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# TUMORS OF THE HAND[1]

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THE hand is the site of a great variety of tumors, many quite rare, some appearing almost exclusively on this extremity, and still others which are common to all regions of the body. Although most tumors of the hand are benign, there are few of them which present simple therapeutic problems. This is due either to the nature of the tumor or to its anatomic relationships. Thus the simple carpal ganglion requires a careful dissection for its complete removal and, if it occurs on the volar surface of the wrist, is likely to be in close relationship to the radial artery which is thus liable to injury. The isolated giant cell xanthoma is closely applied to the nerves and blood vessels of the fingers and frequently lies within the tendon sheaths so that its excision is a matter of careful anatomic dissection in a bloodless field. Removal of a bone tumor may require plastic repair of the osseous defect, and complete excision of cancerous and precancerous areas of irradiation dermatitis frequently necessitates free full thickness skin grafts or pedunculated flaps to cover the raw surfaces. The tendon sheath tumors, particularly the xanthomas and lipomas, may require two or three hours of patient dissection for satisfactory removal.

*Ganglion* (10, 40). Ganglia occur in numerous locations on the hand, the most common being the dorsal carpal ganglion (Fig. 1) which usually takes origin from the joint capsule about the multangulum majus and minus, and pushes toward the surface between the tendons of the extensor indicis proprius and extensor carpi radialis. Some take their origin from the fibrous sheaths of the extensor tendons in this region. The next most frequent location (Fig. 2) is on the volar surface of the wrist, just superficial and medial to the radial artery, where they arise from the fibrous sheath of the flexor carpi radialis and/or the carpal joint capsule. They are not infrequently observed on the dorsal surface of the fingers just proximal or distal to the interphalangeal joint (Fig. 3) from which capsule they take their origin. Those distal to the joint may press upon the nail bed and lead to deformity. Ganglia occasionally occur on the volar surface of the fingers (Fig. 4) as deep, hard, non-fluctuant, spherical masses just distal to the metacarpophalangeal joint, and originating from the fibrous sheath of the flexor tendons. They are likely to be confused with implantation cysts which may also occur in this location, but which attain greater dimensions and are not so truly spherical as ganglia. Ganglia may also occur within the substance of tendons (Fig. 5) where they spread apart the tendon fibers and lead to localized enlargement. Such ganglia occur-

[1] Presented before the Chicago Surgical Society, April 3, 1936. From the Department of Surgery, Northwestern University Medical School and Passavant Memorial Hospital, Chicago, Illinois.

ring on sheath enclosed tendons over the volar surface of the thumb and fingers may lead to the phenomenon of snapping finger.

Although we read in Hippocrates of "certain flabby ganglionic tumors . . . containing only a mucoid flesh," the true nature of these tumors, if they really be tumors, is still somewhat a matter of speculation. The older ideas of synovial herniation have been pretty well exploded, since it is seldom that any communication is found between the cyst and the joint or tendon sheath cavity and, if it is found, it is probably an artefact. When fully developed the ganglion consists of one large cavity (Fig. 6) with no evidence of any connection between the cyst and the synovial space. In fact, the basal tissues (Fig. 7) upon which the cyst rests are thick and dense, part of the fibrous capsule or tendon sheath, and if we examine it carefully we find that it presents numerous cystic degenerative areas of variable size. It would appear that the ganglion starts out as multiple cystic areas which by confluence form one or several larger cysts. Whether this is due to a gelatinous degenerative process in the connective tissue or whether, as has been suggested by King, there is a proliferation of the specialized synovial spindle cells, is still a matter of conjecture.

Numerous methods have been used for the treatment of these tumors. The two most in use today are forcible bursting of the tumor by a blow with a heavy book, and radical excision. It has seemed to me from a study of the histologic character of these tumors that complete excision is the better surgery. This must be performed in a bloodless field and by careful dissection. It is not sufficient to remove the cyst alone, but the tissues from which the ganglion springs must be excised since they contain other cysts or degenerative areas which are likely to lead to recurrence. Transverse incisions are much to be preferred to longitudinal ones for removal of the carpal ganglia. The transverse incision gives excellent access and, since it follows the natural skin folds, heals with a minimum of scar and contracture.

*Epidermoidal cyst* (5, 23, 39, 81), (Fig. 8), is one of the most interesting and frequent tumors of the hand. Despite its benign character and its rather minor importance, a not inconsiderable amount of clinical and experimental literature has grown up about it. The epidermoidal or implantation cyst is a small rounded or oval tumor found most frequently on the volar surface of the hand and fingers. Similar tumors have been described over other surfaces of the body, in the central nervous system, ear, eye, and genito-urinary tract.

The tumor (Fig. 9) is composed of a cystic cavity filled with cholesterol and horny débris and surrounded by a wall of epithelium resembling more or less the normal skin. The absence of hair or other skin appendages differentiates it from the dermoids, while the character of the wall clearly separates it from the simple sebaceous cyst. There are two theories concerning the origin of these tumors—the traumatic and the congenital—and probably both are correct. According to the traumatic theory, a bit of skin is carried down into the subcutaneous tissues by a needle or thorn or other sharp object. Here it grows and proliferates, and the edges of the plaque turn over, fuse, and produce a cyst. Such an origin has been shown to obtain experimentally, while clinical observations are frequent in which a puncture wound has been followed by the development of such a tumor. The traumatic theory is also borne out by the fact that over many such tumors is found a small cutaneous scar. There is no question but that some of these cysts may arise congenitally from inclusions of epidermis during fetal life. However, the very rare occurrence of epidermoids in children speaks against such an origin in the vast majority.

The treatment is simple—that is, complete excision. It is important here, as in sebaceous cysts, that all of the wall be removed; otherwise recurrence is likely.

*Sebaceous cysts.* True sebaceous cysts of the hand (Fig. 10) are quite rare and most so diagnosed are probably in reality epidermoids.

*Xanthoma* (46, 51, 57, 79). The xanthoma as a single, isolated tumor is peculiar to the extremities and along with ganglion and epidermoidal cyst is one of the most frequent of the nodular tumors of the hand. Its exact nature is not settled. Some look upon it as a granuloma, others as a peculiar type of con-

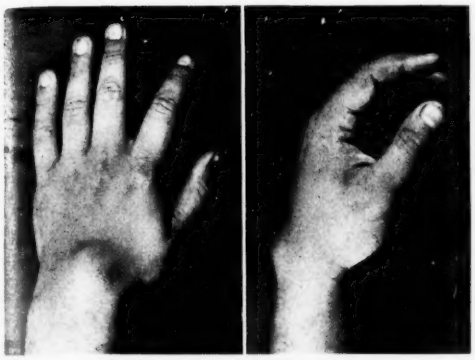


Fig. 1. Dorsal carpal ganglion.

nective tissue tumor, and still others as a bone tumor developing from the sesamoids of the hand and, occasionally, the bones of the wrist. They appear to have their origin in the fibrous tissue of tendon sheaths, fascial layers and ligaments, periosteum, or perineural tissues. They occur as firm, slowly growing, nodular masses, most often on the volar surfaces of the fingers and thumb (Fig. 11) and cause few, or no subjective symptoms. They occasionally, however, occur in the wrist where they produce a clinical picture not unlike that of tuberculous tenosynovitis, and there may even be evidence of bone involvement—a fact which speaks for osseous origin in certain cases. A most striking instance of such a tendon sheath invasion is shown in Figure 12 (frontispiece). The tumor here extended throughout the entire extent of the radial and ulnar bursæ, involved the carpal bones at the base of the thumb, and passed between the second and third metacarpals to the dorsum where it involved all of the dorsal tendon sheaths. The gross appearance of the tumor has been well recorded by the artist. The xanthoma is made up of variably sized lobules of yellow, orange, brown, and gray tissue, bound together by fibrous septa and surrounded by a thin, but definite capsule. Extension along the tendon sheaths is usually noticed in case of tumors on the fingers. The surface mass, if carefully followed, will be found to enter the tendon sheath, extend upward or downward for a short distance, and not infrequently perforate one of the phalanges.

Fig. 2. Volar carpal ganglion.

Microscopically (Fig. 13) the tumors are characterized by four types of cells which vary in relative quantities in different tumors. Most conspicuous are the giant cells of the epulis type containing anywhere from two to several hundred nuclei. The giant cells may be extremely numerous, or they may be quite sparsely distributed, whole areas or even lobules of the tumor may be free of them. Spindle cells resembling fibroblasts are pres-

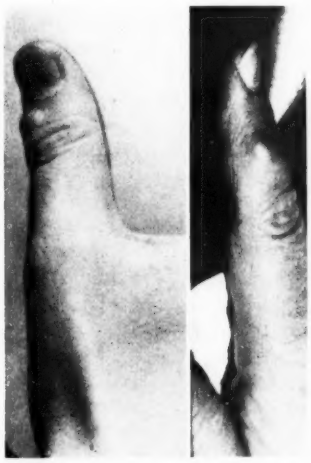


Fig. 3. Ganglia of distal interphalangeal joint capsule.

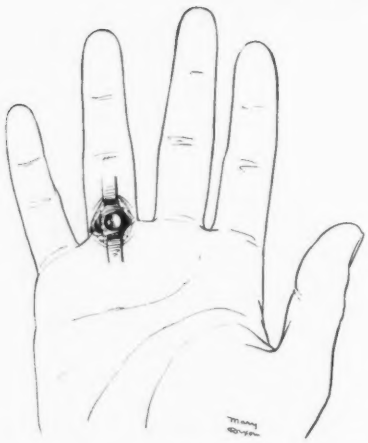


Fig. 4. Ganglion arising from fibrous sheath of flexor tendon over proximal phalanx.

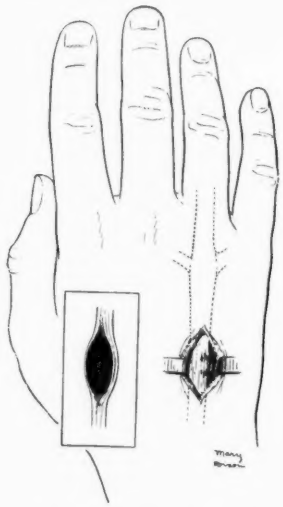


Fig. 5. Ganglion within substance of extensor communis tendon.

ent, associated with considerable amounts of intercellular substance. Large round cells called, variously, endothelial cells, or histiocytes, or tumor cells are typical and are frequently found filled with pigment. The foamy cell is probably the most striking element. It is a large polyhedral cell with one or two pyknotic nuclei and a pale vesicular cytoplasm. If stained with osmic acid or sudan III, these cells will show lipoid globules of cholesterol in which are dissolved carotin and xanthophyll, to which the tumor owes its color. The tumors are benign and require only local removal for cure. Removal must be complete since, if any tumor is left, recurrence is certain to follow. In one instance the histologic characteristics in a recurrent tumor had so changed that we feared a malignancy; however, there has been no further recurrence to date.

*Fibroma* (20, 28, 33, 43). Fibromas may occur on the hand as superficial tumors arising from the skin and subcutaneous tissues (Fig. 14), or as deep fibromas taking origin from the tendon, tendon sheaths, joint capsule, and intermuscular septa. Both types are quite rare and many so diagnosed are probably neuromas. The superficial ones may produce wart-like growths in the corium of the skin and project as hard nodules above the skin level, covered by a layer of normal epithelium. The subcutaneous ones are usually single, spherical or ovoid tumors most often occurring in the palm or volar surface of the fingers. They are occasionally multiple. They may be confused with epidermoid cysts, ganglia, and xanthoma, although these tumors are usually hard and resistant. A soft fibroma (Fig. 15)—fibroma molle—may simulate a fatty tumor. Palmar nodules occurring at the onset of a Dupuytren's contraction are occasionally mistaken for tumors, as are also the dorsal pads on the proximal interphalangeal joint in this condition.

Deep fibromas are much more difficult to diagnose than the superficial ones. They are extremely rare and most of the cases so reported in the literature have been in reality xanthomas or neuromas.

*Lipomas of the hand* (32, 47, 58, 74, 75, 78, 80). Lipomas (Fig. 16) are not frequently found on the hand. According to the literature they are more frequent on the volar than on the dorsal surface. In our experience they have been more frequent on the dorsal surface. They can be conveniently divided into two groups: the superficial, or subcutaneous, and the deep, or subfascial. They differ sufficiently in symptoms and clinical course, as well as in

Fig. 6. Cross-section of ganglion removed from fibrous sheath of flexor tendon. There is no communication between the cavity of the ganglion and the synovial sheath. ×13.25.

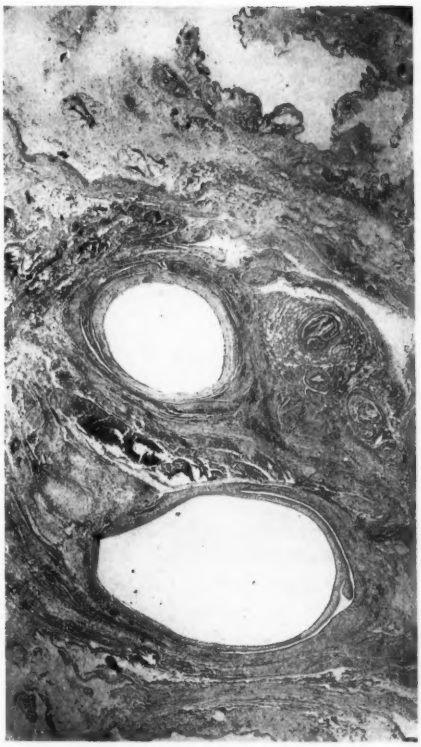


Fig. 7. Microscopic section of basal tissue of a carpal ganglion showing two small cystic cavities. ×16.

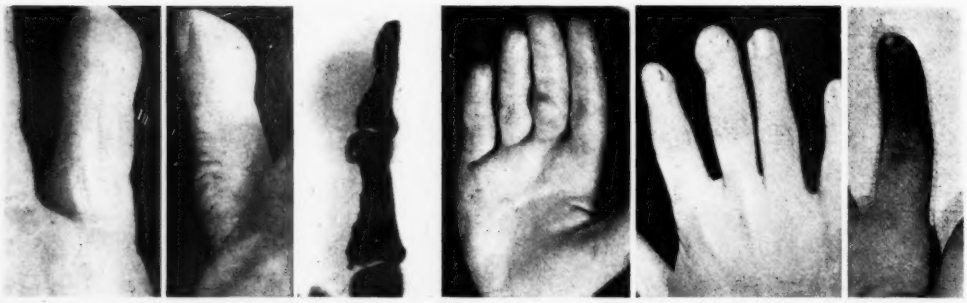
histologic characteristics, to warrant this subdivision.

The superficial lipomas resemble similar tumors elsewhere, except for the fact that lipomas of the hand are more frequently seen in males than in females, again contrary to our rather limited experience in that we have seen but one man with a palmar lipoma. The tumors may grow to considerable size and produce few or no symptoms except the disability due to size. They are usually well encapsulated, show little or no tendency to malignant degeneration, and are easily removed.

The deep or subfascial lipomas may again be divided into two groups, depending upon whether they are without or within the tendon sheaths, into the epivaginal and the endovaginal. Those which lie outside (Fig. 17) the tendon sheaths may lie within any of the fascial spaces, within the muscles, or about the nerves, and may occasionally appear to take origin from the periosteum. These lipomas, while not truly infiltrative in type, insinuate themselves along fascial planes and spaces, becoming constricted under dense bands, and expand again in more lax areas (Fig. 18). They may pass between the metacarpal bones and thus extend from the volar to the dorsal surface. The intravaginal or tendon sheath tumors may be simple lipomas or, not infrequently, may be of the arborescent type provided with numerous villi and extending throughout the course of the involved sheath. The tendons may be thinned out or even invaded, and it may be necessary to remove bits of tendon to eradicate the tumor.

The deeper tumors more often than the superficial ones show variations from the histologic picture of a simple lipoma. Considerable fibrous, vascular, or even myxomatous tissue may be present, there may be areas resembling granuloma or xanthoma, and it is not improbable that some of the so called arborescent lipomas are, in fact, xanthomas. The deep fatty tumors, especially those lying in muscle tissue, show a certain tendency to malignant degeneration.

Considerable functional disturbance may be produced. This may be due to pressure upon nerve trunks leading to sensory symptoms of pain, tingling, and tenderness. The



a b c d e f

Fig. 8. a, b, c, Epidermoidal cyst of left little finger developing 27 years after a thorn prick. d, Epidermoidal cyst of right middle finger following a knife cut. e, Epidermoidal cyst under a free full thickness skin graft. f, Epidermoidal cyst of finger tip following injury with a football cleat 4 months previously.

size and location of the mass may of itself lead to functional disability.

These tumors may reach enormous size and because of the depth and the amount of fibrous tissue present, may not suggest lipoma at all. They may with difficulty be differentiated from a ganglion, xanthoma, fibroma, or even a tuberculous tenosynovitis.

Complete surgical removal is likely to be quite difficult, especially if the process extends from the volar to the dorsal surface, infiltrates muscle planes, or follows the course of the tendon sheaths.

Lipomas may occur on the hand as part of a generalized or diffuse lipomatosis (Fig. 19).

*Telangiectatic granuloma* (21, 22, 42, 56). The telangiectatic granuloma (Fig. 20) or pyogenic granuloma is a relatively infrequent, benign, typical neoplasm about which a not inconsiderable literature has developed. The tumor was originally believed to be due to botryomycotic infection because of its resemblance of mushroom-shaped tumors occurring on the stump of the spermatic cord of horses following castration. Because of this false assumption, the tumor has for a long time been called human botryomycosis and, later, pseudobotryomycosis.

The telangiectatic granuloma is a pedunculated or sessile mushroom-shaped, red, granular tumor, often crusted and purulent. It occurs most frequently on the exposed skin and mucous membranes, and some 30 per cent of recorded cases are found on the hands.

a b c

Fig. 9. a, Cut section (×3.8) of tumor shown in Figure 8 a; the lamellæ given off by the epithelial lining of the cyst are clearly shown. b, c, Microscopic sections of tumor showing the definitely cutaneous character of the lining.

The exact etiology is unsettled. Trauma and infection probably play a rôle. However, the tumor differs histologically from ordinary granulation tissue which it superficially resembles.

On section (Fig. 21), the tumor presents a base, a pedicle, and a body. The base is in the corium and is made up of vascular spaces, telangiectatic or even cavernous in nature. This angiomatous appearance has led many to assume that the tumor develops from a vascular nevus. The body of the tumor partakes more of the nature of granulation tissue infiltrated with leucocytes and polymorphonuclear leucocytes. About the pedicle is a collar of skin from which, in rare instances, a thin layer of epithelium continues over the surface. Little need be said concerning its clinical characteristics. Its marked tendency to hemorrhage and the granulomatous cap differentiates it from the ordinary nevus and angioma, while its tougher consistency and prompt recurrence after incomplete removal differentiates it from ordinary granulation tissue. The treatment is simple complete elliptical excision of the tumor and its base.[1]

*Subungual tumors* (2, 3, 4, 8, 11, 18, 34, 35, 37, 48, 50, 60, 63, 70, 71, 81). Subungual tumors form a small but interesting group of neoplasms of the hand, most of them benign, but the malignant ones are extremely treacherous since they tend to parade under the guise of a chronic granuloma of the nail bed.

One of the most frequent of these tumors is the *subungual melanoma*, or, as Hutchinson called it, the "melanotic whitlow." In some 50 per cent of cases there is a history of injury some six months to a year preceding the tumor, while in other cases the lesion starts as a mole which may remain unchanged for many years and may, without any evidence, undergo malignant changes. In whatever manner it starts out, there is produced an ulcerating process which lifts up the skin and nail and eventually replaces the nail and nail bed with a black fungating ulcer. In not a few instances the lesion may not be pigmented, or the pigment may be confined to a thin black line about the border of the lesion, while in other cases the primary lesion may show no pigment, whereas it is present in the glandular metastases. In most instances the thumb is

[1] Dr. Roger Vaughan has advised the use of a burning glass.

Fig. 10. Sebaceous cyst of the dorsum of the hand.

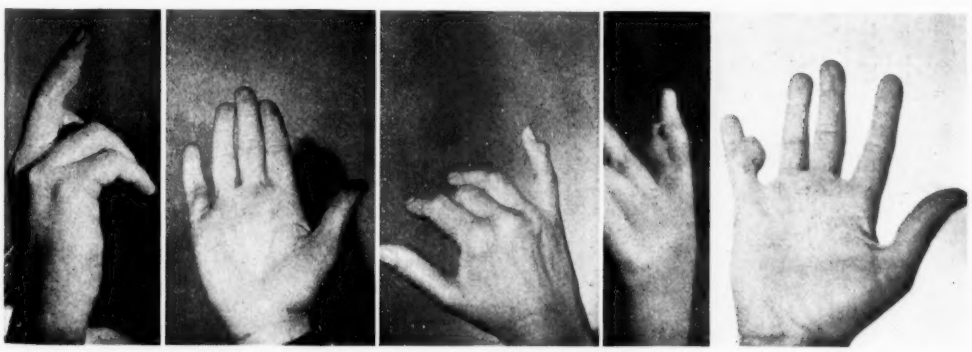


Fig. 11. Four typical examples of isolated xanthomatous giant cell tumors.

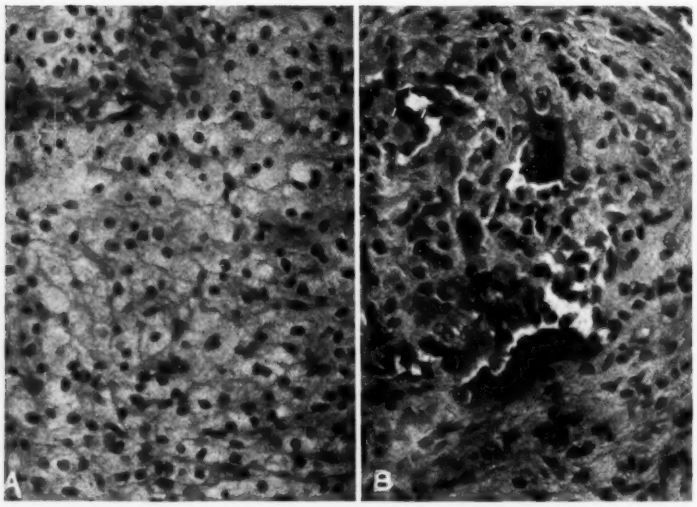



Fig. 13. Microscopic sections of a typical xanthoma. In A, are shown the foamy cells with pyknotic nuclei; in B, giant cells surrounded by endothelial cells and endothelial cells with a considerable amount of intercellular substance.

involved and consequently the lymph node involvement is usually in the axilla.

Bad as is their prognosis, the subungual melanoma presents the best chances of cure of any of the melanomas. A certain number of cases have survived up to four years following amputation of the finger and axillary dissection.

The *subungual carcinoma* (Fig. 22) also begins as a granulating lesion, usually after trauma, and is frequently treated for some time as a chronic paronychia. Except for its unusual location, it presents no feature which sets it apart particularly from other carcinomas. It is treated best by amputation and axillary dissection.

*Subungual exostosis* (Fig. 23), while a generally recognized though infrequent lesion of the foot, is extremely rare on the hand, and less than a dozen instances have been re-

Fig. 14. Subcutaneous fibroma at base of thumb.

Fig. 15. Fibroma molle, proximal phalanx of thumb.

Fig. 16. Lipoma of ulnar border of hand.

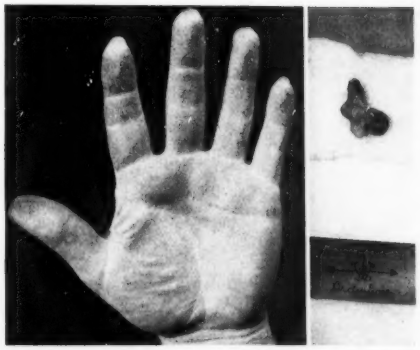


Fig. 17. Subfascial lipoma in lumbrical canal, projecting into subfascial space of index finger.

ported. Of the reported cases, most have involved the index finger, contrasting with their most usual occurrence on the foot under the nail of the great toe. It is not improbable that some of these have been in reality supernumerary digits. The subungual exostosis occurs as a chronic, slowly growing, painful tumor which tends to push up the nail, and may give rise to a chronic granular purulent mass. Treatment consists of removal with the least possible damage to the nail bed.

The *glomus tumor* (Fig. 24) has suddenly leaped into prominence in this country during the past few years, and we are discovering that it is not a rare tumor after all. Although the

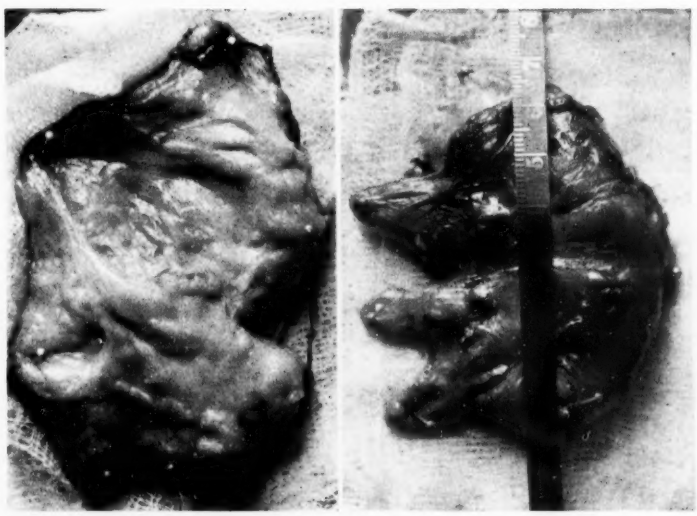


Fig. 18. Subtendinous lipoma of the palm (courtesy of Dr. D. H. Mendelsohn, Paterson, New Jersey). The "mass was imbedded behind the palmar fascia on the thenar side and extended under the annular ligament. The three projections were imbedded crosswise under the flexor tendons of the ring finger."

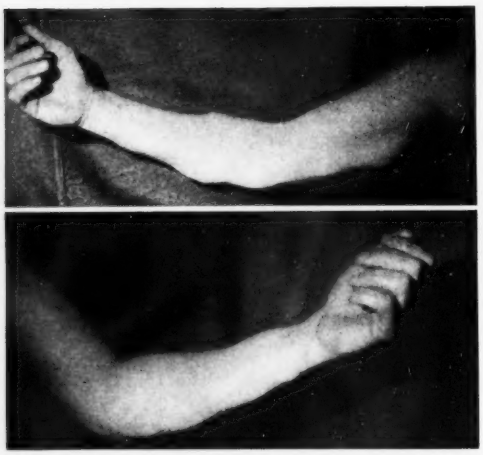


Fig. 19. Diffuse lipomatosis of both upper extremities.

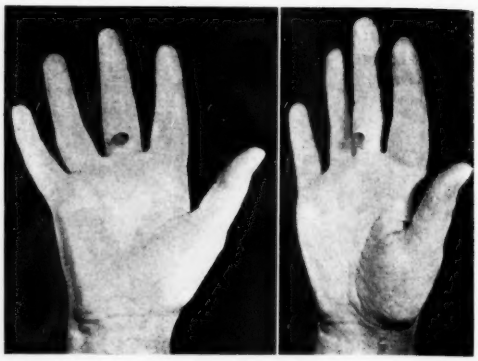


Fig. 20. Telangiectatic granuloma of right middle finger.

nail bed is its most frequent site, it occurs elsewhere on the body, most frequently on the hands. It develops from the neuromyoarterial glomus of Masson (Fig. 25), which is an arteriovenous anastomosis fairly well supplied with nerve fibers and found scattered in the skin especially of the extremities. It appears to have something to do with local circulation and heat regulation. The tumor, known as the glomus tumor, is an enlargement of this structure and it is a question whether it is, in fact, a true neoplasm. It has been suggested that it is best looked upon as a hypertrophied glomus, or a hamartoma. When these structures enlarge, they produce masses which grossly resemble an angioma. Clinical and microscopic study, however, have shown them to be otherwise.

They are found to be made up of blood vessels with thickened walls (Fig. 26) in which the media is replaced by epithelial cells interspersed with smooth muscle cells and myelinated and unmyelinated nerve fibers. Al-

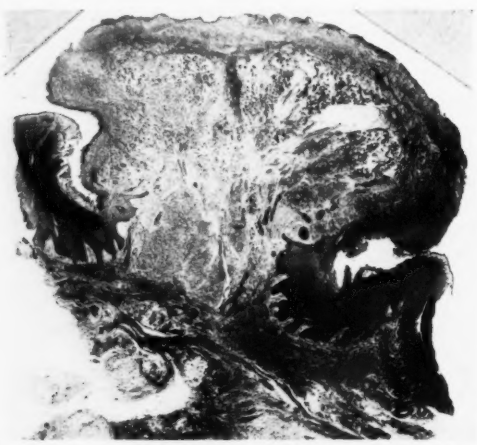


Fig. 21. Photomicrograph (low magnification) of telangiectatic granuloma shown in Fig. 20.

Fig. 22. Subungual carcinoma subsequent to crushing injury.

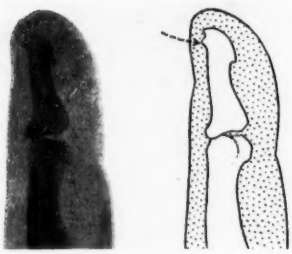


Fig. 23. Subungual exostosis of a finger (courtesy of Dr. Earle Greene).

though Masson believed nerve cells were present, we have never been able to demonstrate these satisfactorily.

Regardless of location, but more particularly in case of the subungual glomal tumor, a very typical clinical picture is produced. Following trauma, or more frequently without such a history, the patient complains of attacks of pain, at first confined to the finger or finger tip, often without any local evidence of trouble. These painful attacks become more and more severe and more and more frequent, and a bluish fleck or nodule is noted under the nail. With the appearance of the nodule the pain tends to radiate up the arm and since any pressure on the tumor sets up

Fig. 24. Subungual glomus tumor of ring finger (after Lortat-Jacob and Brosse, Bull. Soc. d. franç. de dermat. et syph., 1928, 35: 303).

an attack, the patient learns to protect the hand and uses it less and less.

Examination reveals beneath the nail a bluish discoloration into which several blood vessels seem to flow. Pressure on the nail may lead to partial disappearance of the mass. X-ray examination of the finger may show a depression on the distal phalanx at the site of the tumor.

While the patient will receive some temporary relief from scraping away the nail from above the tumor, pain reappears as soon as the nail grows back again. Proper treatment consists of simple removal of the tumor which permanently relieves the pain.

Other tumors of the nail bed are of much greater rarity and need only be mentioned. They include enchondroma, leiomyoma, fi-

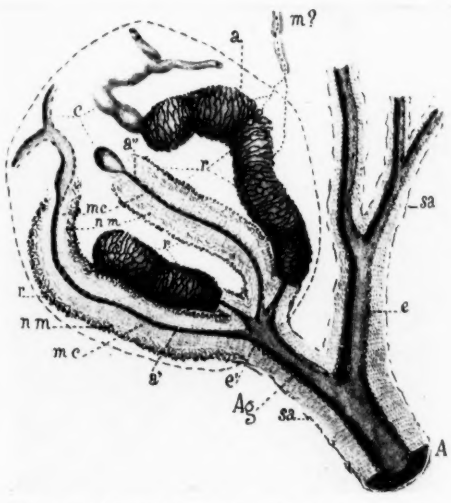



Fig. 25. Schematic reconstruction of a subcutaneous glomus (after P. Masson, Lyon chir., 1924, 21: 257, Fig. 6).

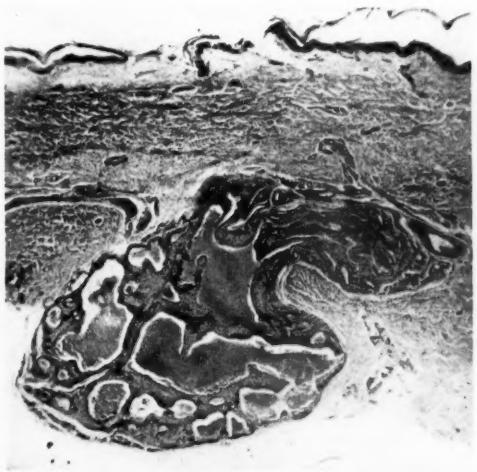


Fig. 26. Section through a glomal tumor. Demonstrates the vascular structure which is separated from the environment by a loose capsule of connective tissue fibers. ×12. (From article of Mason and Weil, Surg., Gynec. & Obst., 1934, 58: 807–816.)

Fig. 27.

Fig. 30.

Fig. 27. Metastatic chorionic epithelioma of nail bed in male patient with tumor of the testis (courtesy of Dr. L. W. Riba).

Fig. 28. Roentgen carcinoma of dorsum of hand of a physician (from F. R. Zeit Museum of Pathology, Northwestern University Medical School).

Fig. 29. Roentgen dermatitis.

Fig. 28.

Fig. 31.

Fig. 29.

Fig. 32.

Fig. 30. Roentgen dermatitis and carcinoma. The middle finger had previously been amputated for the same condition.

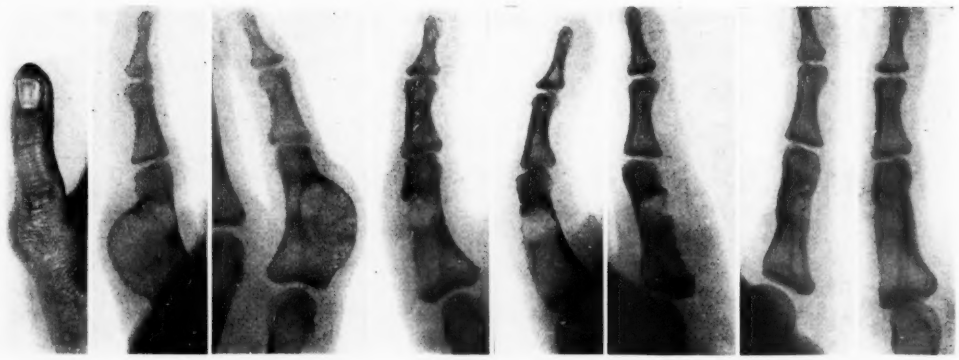
Fig. 31. Carcinoma of palm developing in scar of an old injury (from Mason, M. L. Arch. Surg., 1929, 18: 2107-2158).

Fig. 32. Carcinoma of palm developing in tract of puncture wound (courtesy of Dr. J. J. Lebowitz—from Mason. Arch. Surg., 1929, 18: 2107–2158).

broma, multiple subungual fibroma, papilloma, sarcoma, and warts.

*Metastatic tumors* of the nail bed are of great rarity; the one here illustrated (Fig. 27) is a chorionic epithelioma in a male with tumor of the testis.

*Carcinoma of the hand* (1, 14, 19, 29, 31, 49, 59, 76, 77). Carcinoma is by far the most important and most frequent of the malignancies involving the hand. It occurs most frequently on the dorsum and is often referred to in the literature as carcinoma of the back of the hand. The majority are squamous cell lesions, and in the history of most patients there appears some irritative factor to which we can ascribe etiologic significance. This factor may be: exposure to irradiation, roentgen (Figs. 28, 29, 30), radium, or sunlight—either chronic or acute; scars such as follow burns or other injuries (Figs. 31, 32); chronic infections, especially lupus and particularly this if radiation therapy has been used; chemical irritants such as acids, alkalis, tar, pitch, paraffin, gasoline, oil, grease, paint, internal



a b c d e f g h

Fig. 33. Enchondroma of left fifth finger of 6 years' duration, of a girl of 15, first noted after an injury at age of 9. Rapid growth for a few months associated with constant aching pain, since when tumor has been stationary and painless. At operation, the thin bony shell was removed, the pearly gray cartilaginous tumor curetted out, and the cavity swabbed with Zenker's solution. a, Photograph of finger before operation. b, c, Roentgenogram previous to operation. d, e, f, Roentgenogram made 2 weeks after operation. g, h, Roentgenogram made 3½ months after operation.

medication (of which arsenic is the best example), and chronic mechanical irritation such as occurs in certain types of work. Some develop in a previously benign lesion, such as a wart, or keratosis in the aged, and here there is not rarely the history of some ill-advised efforts at self-treatment. In about 20 per cent of the cases, the tumor arises in previously normal untraumatized and non-irritated skin.

The carcinomas following exposure to roentgen or radium irradiation are of considerable interest to the medical profession because of the many victims among our own ranks. Ouidin, in 1897, scarcely two years after Roentgen's publication of his discovery, warned the profession of the possible dangers attached to the use of the x-ray. The late Charles A. Porter, of Boston, published his first paper on roentgen carcinoma in 1907, and we owe a great debt to his pioneer work.

We are here interested especially in the carcinoma which develops on the basis of chronic recurrent exposures to minute doses of x-ray or, occasionally, radium. This is seen not only in professional radiologists among whom it would appear to be decreasing in frequency, but also on the hands of physicians who use the x-ray occasionally in conjunction with their other work. Many of the patients we have seen have been general practitioners who have used the x-ray in the reduction of fractures, in search for foreign bodies, and in fluoroscopy. A single over-exposure to irradiation may result, of course, in a severe burn and from this, painful ulceration on the basis of which a carcinoma may develop. However, the typical roentgen carcinoma follows chronic repeated exposure to minute doses and develops on the basis of a chronic roentgen dermatitis. Typical of this dermatitis is the long interval between the onset of exposure and the development of skin manifestations, and between the development of the dermatitis and the occurrence of malignant changes. Years of exposure precede the appearance of real trouble. The "roentgen hand" (Figs. 29, 30) with its keratoses, telangiectatic spots, atrophic, dry and roughened skin and brittle deformed nails is well known. It may persist for many years without remarkable change and may even appear to regress slightly when exposure is stopped. However, a certain amount of irreparable damage has been done and the process once started tends to perpetuate itself.

The development of malignancy is ushered in by the appearance of cracks or ulcers through areas of keratotic or altered skin. Peculiar to this process is the fact that not one but several ulcers or fissures may occur, some

Fig. 34. Periosteal chondroma of proximal phalanx of fifth finger.

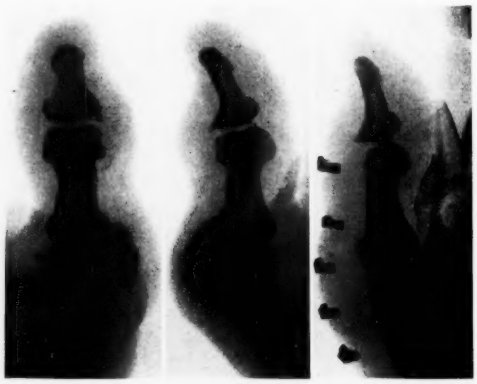
Fig. 35. Giant-cell tumor of metacarpal bone of the left thumb.

may heal permanently, others heal only to break down again, while some persist. It is also characteristic of the process that new ulcers and fissures appear from time to time. Here, of course, lies the treacherousness of the condition in that the dorsum of the hand may be the seat, not of one but of numerous carcinomas and that following the removal of one or more definite malignancies, new ones may spring up in altogether new locations.

In the early mild cases, local excision of all suspicious areas as they arise may be all that is required. In the more advanced and severe case, it is advisable to excise *en masse* the entire involved skin from the back of the hand and fingers and replace it immediately by a pedunculated or pocket flap or split graft. Where deeper structures than the skin are invaded, or where a finger is severely involved by an ulcer, amputation is called for and dissection of the axillary and epitrochlear glands is indicated. It does not seem logical to expose such tumors to therapeutic irradiation.

Carcinomas developing in burn scars are of especial interest since they develop many years—five to sixty—after the burn; in fact, nearly all cases are seen in elderly people who sustained the burn in childhood.

Fig. 36. Exostoses of carpometacarpal, metacarpophalangeal, and interphalangeal joints of right thumb. Tumors were thought to have developed after injury.



a b c

Fig. 37. Roentgenograms of exostoses shown in Figure 36. a, b, Before operative removal. c, After operation.

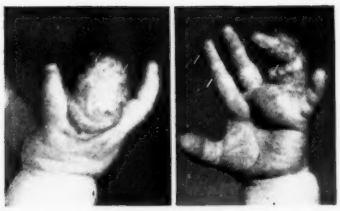


Fig. 38. Congenital hemangioma (courtesy of Dr. S. L. Koch), mixture of capillary and cavernous type, in infant of 2 years. Treated by excision and free full thickness skin graft.

Fig. 39. Cavernous angioma of thenar eminence.

*Chondroma* (6, 24, 26, 44, 53, 54). The chondroma (Fig. 33) is the only bone tumor which occurs with any frequency on the hand and, curiously enough, the hand is by far its most frequent location. It occurs most often as an isolated tumor located in the shaft of a metacarpal or phalanx and has never been recorded in a carpal bone. Although it occurs at any age, it is most often seen in patients under thirty years—a fact which suggests a congenital origin.

The tumor is confined to the shaft of the bone and although the cortex is markedly expanded over a half to two-thirds of its circumference, the tumor rarely breaks through and invades the soft parts. Fracture of the bone through the tumor area is frequent, but even then soft-tissue invasion does not occur. On cutting down on the tumor, the nerves and tendons will be found to be uninvolved, though often pushed aside or stretched and flattened over it. The tumor itself is a pearly translucent gray, or a light yellow gelatinous or gummous mass, poorly vascularized and easily separated from the surrounding bone with a curette. Except for the presence of a hard, slowly growing, or stationary tumor, few symptoms are present. In fact, the occurrence of a pathologic fracture may be the first evidence.

Fig. 40.

Fig. 41.

Fig. 42.

Fig. 40. Fibro-angioma of hypothenar eminence. On microscopic section the new-growth appeared to be a fibrous tumor containing large blood channels, most of which were obliterated by recent fibrosis or by old organized thrombi.

Fig. 41. Congenital lymphangiectasis, a rare condition characterized by a diffuse firm swelling of the extremity.

Fig. 42. Nerve sheath tumor of small ramus of digital nerve.

Fig. 43. Plexiform nerve sheath tumor of median nerve and its digital rami; associated with slight overgrowth of middle finger.

The roentgen findings are fairly definite and help to differentiate it from the only bone tumor with which it might be confused—the giant cell tumor. The latter is seen practically only in the metacarpals, and there quite rarely, and in x-ray is somewhat more definitely trabeculated and vesicular than the chondroma. Bone cysts, sarcoma, metastatic carcinoma, and myeloma are infrequent and have rather typical roentgen findings. The tumor is essentially benign, but may recur after incomplete removal. It does not have the tendency to sarcomatous degeneration, evidenced by chondromas situated nearer the trunk.

Fig. 44. Elephantiasis nervorum involving index finger, thumb and thenar eminence. Condition present since birth.

Treatment consists of complete removal, usually with a curette and chemical cauterization of the cavity with Zenker's solution or 50 per cent zinc chloride. Usually, some portion of the shaft of the bone will be found strong and intact, and this will preserve continuity. When the entire shaft is so thinned that it cannot be preserved, an autogenous bone graft may be used, or some other method used to replace the bone. Only if repair is impossible should a finger be amputated for chondroma.

*Periosteal type of chondroma.* Occasionally the chondroma does not lie within the bone, but is found attached to the periosteum and may invade the cortex (Fig. 34). McWhorter has reported an interesting case of this kind in which the proximal phalanx and metacarpal of the right thumb were entirely surrounded by a cartilaginous tumor separated by periosteum from the bone, except in one spot.

*Giant cell tumor* (12, 17, 41). The giant cell tumor (Fig. 35) is occasionally met with in the metacarpals, and more rarely in the phalanges, of the hand where it may be confused with a chondroma. Few, if any, subjective symptoms are produced, though pain and tenderness may occasionally be present.

Pathologic fracture may occur through the tumor, but this is rarely the initial symptom as it may be in chondroma. The giant cell tumor may usually be distinguished from enchondroma in the roentgenogram. The giant cell tumor has a peculiar "soap-bubble" appearance in that numerous trabeculæ run through the tumor and divide it into many small translucent areas. In the later stages, these trabeculæ tend to disappear. In the chondroma, the trabeculation is not so marked; however, the difference is only relative and not absolute.

Treatment consists of complete local removal, accomplished by curettage followed by chemical cauterization. Recurrences should be treated in the same fashion. Irradiation is of uncertain value.

*Exostosis* (26, 30). Exostoses are extremely rare on the hand. The subungual exostosis has been previously noted. The case here shown (Fig. 36) is that of a man who had sustained injuries to the metacarpophalangeal joint 15 years previously, and to the interphalangeal joint 8 months previously. The swellings had appeared following these injuries. The bony excrescences were simply chiseled off and shown to be new bone capped with irregularly formed hyaline cartilage.

*Angiomas* (9, 15, 16, 27, 38, 45, 55, 64, 65, 66, 67, 68, 69, 82). Practically all of the variously described vascular tumors are found on the hands, where they present the same difficult therapeutic problems as elsewhere. Following the lead by Reid, de Takats, and others who have studied the problem especially, it would seem logical to assume that most of these tumors can be ascribed to developmental arrests in parts of the vascular tree in various stages of its growth. Sabin, Woollard, and other coworkers of Sabin have shown that the development of the vascular system can be divided into four stages: the angioblastic stage, characterized by the formation of vasoformative cells from the primitive mesenchyme; the capillary plexus stage; the retiform stage, in which a series of coarsely plexiform, branching and diffusely anastomosing vessels are produced; and lastly, the stage of stem formation by a process of coalescence. "These successive stages provide abundant opportunity for variation and the production of anomalies" (Woollard).

For clinical purposes, we may classify the angiomas roughly into four groups: the angioblastic, the telangiectatic, the cavernous, and the vessel type of tumor. There are numerous transitions and admixtures between the capillary and cavernous type (Fig. 38), whereas, the vessel type is frequently associated with, or may start out as a capillary or cavernous angioma. The vessel type presents a most interesting problem. Some of these tumors are thought to be due to the active proliferation of blood vessels, either arterial or venous, and these have been called cirsoid aneurysms. Others have been assumed to be due to congenital dilation of either the veins or veins and arteries of a certain area (phlebectasia and phlebarterialectasia). Still others appear to be due essentially to multiple or single arteriovenous communications (congenital arteriovenous fistula). The vessel types of angiomas tend toward progressive increase in size, encroachment upon normal surrounding tissues, and to the production of seriously disabling or even fatal complications.

The angioblastic type of angioma is a great rarity (Geschickter and Keasby).

The telangiectatic angioma is usually simply a cosmetic blemish, but may enlarge, or may be the forerunner of a progressively extending tumor. If removal is indicated by evidence of growth, or because of disfigurement, excision may be performed. When the growth is very large, the defect left by excision may require plastic closure by means of skin grafts. Coagulation by means of carbon dioxide snow, or thermal cautery or electrocautery have been used successfully. Radium has come into prominence in the past few years in the eradication of these tumors; however, the application must be made by an expert lest the angioma be replaced by the telangiectasis of irradiation or radium dermatitis.

The cavernous angiomas (Fig. 39) may be excised. This is not infrequently a difficult procedure, especially if the tumor is at all extensive. Although a bloodless field is advantageous during the operation, it is surprising how many vessels will be found to have

been missed when the constriction is released. Meleney has recently reported the successful treatment of a multiple cavernous angioma by the use of chemical injections over a considerable period of time. The intramuscular angiomas and tendon sheath angiomas, usually cavernous in type, should be carefully excised.

The vessel type of angiomas present interesting physiologic, diagnostic, and therapeutic problems. If large and extensive, and especially if arteriovenous communications are present, hypertrophy of the affected extremity occurs, serious nutritional disturbances may develop, and ulceration, gangrene, and serious hemorrhage are threatening complications. In the advanced case, changes in blood pressure on the involved side (increased systolic and decreased diastolic) may be noted and with this, cardiac hypertrophy. The veins may be shown to carry arterial blood by determination of the oxygen content and capacity. The determination of the site of arteriovenous communication may be quite difficult and when these are multiple, as they frequently are, surgical obliteration of the communication may be impossible. The use of radio-opaque substances intravenously, as practiced by Vernon David and Ghormley and Horton, may demonstrate the anastomosis.

Some of the more simple of the vessel type of angiomas may be completely excised without much difficulty. In the cirsoid and arteriovenous aneurysms and ectasias, we must often be satisfied with partial operations. The use of the alternating negative and positive pressure apparatus of Hermann renders possible more complete excision and has diminished the danger of postoperative gangrene.

A mixture of angiomatous tissue with other tissues, e.g., fat and fibrous tissue (Fig. 40), are occasionally met with.

*Congenital lymphangiectasis* (52). Congenital lymphangiectasis (Fig. 41) is a rare condition characterized by a diffuse, firm swelling of an extremity. It is present at birth and may be associated with hypertrophy of the part. The extremity pits on pressure, the swelling diminishes very slowly with elevation or compression, and returns to its usual size only very slowly. Incisions in the tissue or ulcerations bleed lymph. Pathologically, there is replacement of the normal subcutaneous fat by dilated lymph spaces and fibrous tissue.

Treatment is quite unsatisfactory, though the Kondoleon operation has been used with some success.

*Tumors of the peripheral nerves* (7, 25, 61, 62, 72, 73). Tumors of the peripheral nerves are not of such rare occurrence as has been generally assumed; in fact the pendulum has swung so far to the other side that there are some who state that most, if not all, fibromas and spindle cell sarcomas of the skin and subcutaneous tissues of the extremities are derived from the nerve sheaths. While this position is probably somewhat overstated, it serves the purpose of emphasizing the importance of considering nerve sheath tumors in the diagnosis of tumors of the hand. Opinion concerning the histogenesis of the nerve sheath tumor is considerably divided. Some would derive all of the nerve sheath tumors (the false neuromas of Virchow) from the sheath of Schwann, others believe that while the sheath of Schwann produces a specific tumor (perineurial fibroblastoma, schwannoma, peripheral glioma, neurinoma, neurilemoma), other tumors (among them those arising in von Recklinghausen's disease, and the great majority of nerve sheath sarcomas) are produced by proliferation of the fibrous, or fibrous and schwannian, elements of the sheath. The recent publication of Stout and of Geschickter give excellent surveys of the present status of the problem.

The neuromas of the hand may be present in any of several different forms. The tumor may occur as an isolated fibrous-like nodule, either pedunculated with a broad base in the skin, or as an intracutaneous nodule, frequently diagnosed as fibroma molluscum. Similar tumors, but multiple, occur in von Recklinghausen's disease. Not infrequently the neuroma occurs as a subcutaneous nodule (Fig. 42) derived from a superficial nerve. These tumors are rarely painful and only occasionally tender, are globular or ovoid in shape, and are often mistaken for ganglia, lipomas, or other tumors. They may be quite

soft, or tense and firm. Similar tumors may be found on the median or ulnar nerves in the palm and wrist, or associated with the volar digital nerves on the fingers. In removing these tumors, care should be taken to preserve, if possible, the nerve fibers which take no part in the formation of the neoplasm. In case of small cutaneous nerves, sacrifice of the branch will be necessary; however, when dealing with the larger nerve trunks it will usually be possible to remove the tumor from the surface of the nerve, or separate it from the nerve bundles which will be found coursing over its surface. Such a tumor embedded in the substance of the median nerve will expand in all directions so that nerve bundles will lie over it like the bands of an expanding bougie. If the nerve is split longitudinally, the tumor may often be shelled out with a minimum of damage.

Plexiform neuromas may occur as part of a generalized von Recklinghausen's disease, or may be the only manifestation of the same, with strict limitation to one extremity or even a part of one extremity (Fig. 43). There may be associated with this hypertrophy of the involved area, the blood vessels, connective tissues and even bones enlarging to produce what has been called elephantiasis nervorum (Fig. 44).

Malignant tumors of the peripheral nerves are more frequently seen in association with von Recklinghausen's disease than as isolated tumors. When first seen they may not suggest in any way the presence of malignancy, however, their steady growth and prompt recurrence after removal will establish the diagnosis. These tumors must be very widely removed and the nerve segment from which they are derived should be excised. Amputation is not infrequently called for.

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NOTE.—References here given include but a small percentage of those consulted and available, but will furnish a key to the literature.

# ARTERECTOMY

## With Follow-up Studies on 78 Operations

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WE present this discussion of arterial resection as an operation of choice, because we are convinced that it offers an effective and active method of treating localized arterial obliterations. From a review of the literature it appears that this operation has been employed occasionally, but most often as an emergency procedure following necessary arterial ligation, or when the surgical treatment of aneurism has involved arterial resection. The idea of resecting obliterated arteries is not new, but its use in the active treatment of obliterative arterial disease has received little attention in recent years. That it is not a specific cure for all the vascular conditions in which we have tried it is evident from our follow-up results, but that it does afford evidence of very definite improvement in circulation and amelioration of symptoms in many cases, we are convinced.

### HISTORICAL AND REVIEW OF AMERICAN LITERATURE

The first publication of the results in 6 cases of arterial resection was made by one of us (Leriche) in 1917 with the collaboration of T. Heitz (10), and since that time we have continued to study, both clinically and experimentally, the use of this operation in the therapeutic problem of localized arterial occlusions. Most of these early cases were the results of wounds received during the Great War, and the arterial obliterations found had produced definite peripheral vascular disturbances, which evidently could not be attributed solely to the diminution in blood-flow to the extremity. We believed that the pain, edema, cyanosis, and trophic ulcerations were the results of a vasomotor reflex, for the resection of the obliterated artery did not modify the mechanical state of the circulation, but it did cause all of these signs and symptoms to disappear. This temporary relief of symptoms is not difficult to understand, but when we find the results lasting for years we are at a loss to offer an adequate physiological explanation for this result which we have observed in many patients.

In 1920 Halsted published a clinical observation which strengthens the argument for arterial resection. During an operation for aneurism of the left subclavian artery in 1918, he ligated this vessel and also the left axillary artery, with symptomatic improvement to the patient. The left hand remained cool and cyanotic, however, and showed only slight improvement in the next 2 years. In 1920, at a second operation, the obliterated aneurismal sac was excised and Halsted was surprised to find the left hand now warmer than the right 6 hours after operation, and this condition still present 56 days later when the patient was again seen. This is the same type of hyperemia which we have observed in most of our patients following arterectomy.

The next important contribution to the American literature on arterial resection was made by Lewis and Reichert in 1926, when they presented several cases of arterial ligation, one of which was combined with resection of less than one inch of obliterated artery. In this case of limited arterectomy they noted the prompt relief of pain and likewise reported no evidence of developing gangrene following resection. These authors, along with Meleney and Miller previously, demonstrated by injection methods the unusually rich anastomotic network which developed in those limbs which had been amputated because of gangrene, as the result of a pathological femoral occlusion. Because of these clinical and pathological findings they advised arterial ligation in selected cases to (a) encourage collateral circulation; (b) to do away with pain from

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arterial spasm; and (c) to inhibit the rate of occlusion in other vessels. Unfortunately, because of the limited number of cases presented, they were unable to distinguish between the marked improvement which we have observed following resection, as compared to the less definite results in cases of simple ligature. We should also mention that the resection of less than 1 inch of arterial wall in this one case is hardly comparable, in the way of clinical results, to the operation of arterectomy as we perform it, where routinely 6 to 8 inches of femoral artery are resected.

Lehman, in 1930, first presented a series of several cases of arterial resection in which he noted very definite improvement following operation. Here again, the resected arterial trunk was only 1 to 2 centimeters in length, and he concluded the report by stating that one could not hope for a more permanent effect than that of peri-arterial sympathectomy, which in his hands had lasted only from 4 to 6 weeks. Finally in 1931, Leriche (7) presented the clinical and experimental background for our work on arterial resection; this we will review further on in this paper.

In the experimental study of collateral circulation there have been several papers published to show the improved results from simultaneous ligation of the vein and artery. In 1923 Brooks and Martin found evidences of greater collateral circulation when venous ligation was combined with arterial occlusion, and only recently, Brooks, Johnson, and Kirtley, in a larger series, were able to report similar findings. Holman and Edwards reported even better results from higher simultaneous ligation of the concomitant vein, and Pearse confirmed these findings by arteriography in living animals. On the other hand, both Wilson, and Mulvihill and Harvey were unable to find evidences of increased collateral circulation as originally reported by Brooks and Martin. In 1930, we (Leriche and Fontaine, 8) found a definite increase in collateral circulation, but our studies led us to the conclusion that the finer results were the direct consequences of a "masked sympathectomy with active vasodilatation" caused by simultaneous vein ligations, rather than the mechanical increase in peripheral pressure.

It thus appears that most of the reports in the literature deal with the results of arterial ligation, and that the question of arterial resection, which in our hands has given far better results, has received scant attention.

### EXPERIMENTAL BACKGROUND FOR THE OPERATION OF ARTERECTOMY

After several years' trial with arterial resection clinically in a number of cases, we were led to an experimental study of the innervation of the arterial walls in the rôle of establishing collateral circulation. This work is published in full detail in a recent monograph by Leriche and Stricker (11), but we wish to summarize those experiments which have led us to the conclusion that "the state of the arterial wall is of greater importance in the establishment of a collateral circulation than the arterial lumen itself."

Stricker and Orban, working with dogs, were able to remove all of the large arteries in the hind limbs when they operated in 8 to 9 separate, successive stages spaced at intervals of from 10 to 30 days. The arteries removed included the posterior tibials, the anterior tibials, the femorals, the inferior gluteals, the lateral sacrals, the hypogastrics, the external iliacs, and, at the final stage of each series, the common iliacs, and the bifurcation of the aorta were resected. In carrying out this extensive arterial resection by multiple operations, well spaced, they seldom noticed any reaction beyond an occasional, temporary edema which rapidly disappeared. In this manner they succeeded in literally producing "dogs without arteries," for in several cases they extended the resection to include the arteries of the fore-limbs. Several of these dogs were studied for a period of months, and they always were able to walk about, stand on their hind legs, and jump over objects with the same facility as normal dogs.

In another series we studied the comparative effect of simple ligation with resection of the corresponding artery. In practically every case the collateral circulation was established after approximately 30 hours on the resected side, whereas, generally 2 to 3 days were required for the development of an adequate collateral circulation following ligature. By

studying the collateral circulation with injections of an opaque material by roentgen ray examination, we noted that the collateral arteries were much more numerous after resection of a large arterial trunk than after simple ligation.

The next step was an attempt to make a massive resection of the main arteries of both hind limbs in one operative stage, including the aortic bifurcation and common iliacs. Every dog subjected to this operative procedure died within a few days with evidences of marked edema, cyanosis, drop in skin temperature, and loss of motor function of the hind legs. When, in a preceding operation, however, the lumbar sympathetic chain was removed on each side, these grave signs and symptoms did not appear, and the animals were only slightly disturbed by this extensive arterectomy. After 24 hours the hind legs were warmer than the fore-legs, and within 6 days the animals were able to walk, run, and jump without any impairment of normal function. In this series no trophic lesions appeared even though some of these animals were permitted to lead an active life for several months following operation. In each case the rich anastomotic arterial network could be demonstrated by injections of radio-opaque substances, and this tremendous development of muscular and subcutaneous anastomotic vessels seemed to be in direct relation to the extent of the resection.

Dolgo-Saburoff, in similar studies of circulation following arterial resection, likewise found greatly increased anastomoses in the subcutaneous and muscular tissues, but also in the bony tissues. In 1932 Rodrigues repeated our series of experiments with findings which substantiated our own.

These experiments, then, have led us to an appreciation of the important rôle which the lumbar sympathetic nerves, and also the parietal innervation of the arterial walls, play in the regulation of peripheral circulation. We also believe that they help to demonstrate the important function of these nerves in the vascular disturbances which follow arterial occlusion, and hence to justify the liberal resection of the obliterated artery in all such cases.

## CLINICAL INDICATIONS WITH DISCUSSION OF THEORY

As the result of our clinical experience with arterial resection during the past 20 years, we have found that we can hope for greater improvement in certain conditions involving arterial occlusion, than in others. In general, good results are obtained in cases of monoarteritis, such as follow trauma, freezing, surgical ligation, and occasionally embolus. Of the generalized vascular diseases thromboangiitus obliterans has given unsatisfactory results when treated by arterectomy alone. In arteriosclerosis we have seen definite improvement over a period of several years, but especially when the obliteration was not too extensive in the thigh, and when the patient presented himself for operative aid before the terminal signs of gangrene were apparent. Occasionally one sees reports in the literature of no improvement following peri-arterial sympathectomy or arterectomy, but we believe that many of these failures represent the result of applying these operative procedures to terminal gangrene cases where one can logically expect failure. In favorable cases we often supplement arterectomy with lumbar ganglionectomy, ramisection or, in thromboangiitis obliterans, with a unilateral suprarenalectomy based upon the original ideas of Opel. Realizing that lumbar sympathectomy ordinarily gives better results we often resort to this procedure in selected cases without attempting arterectomy. In several series reported, the follow-up studies have indicated about 80 per cent satisfactory relief of symptoms, but at the same time a mortality of 4 per cent. Since arterial resection is a much safer procedure and capable of affording relief of symptoms in a good percentage of cases, it should be employed by preference in most patients.

Arterectomy is an operation which must be reserved for selected cases of occlusion if one hopes to obtain relief of symptoms. As a general principle we now employ this procedure for cases in which we can prove localized arterial obliteration with patent vessels distally. Often these patients present very few symptoms, and one is surprised to find how frequently complete obliteration of a portion

of the femoral artery exists, as demonstrated by routine arteriography, in elderly persons who walk about with little difficulty and with no evidences of gangrene.

Arterectomy is contra-indicated whenever any acute or chronic infection exists, likewise, the age of the patient must be considered, and also the nature of the obliteration, remembering that thrombo-angiitis obliterans is least likely to give favorable results from this operation alone. One other important factor is the location of the obliteration! Occluded superficial femoral and brachial arteries give the best results, probably because they are practically without branches for a good distance, and enveloped in great muscular layers. When good collateral vessels can be demonstrated, the external iliacs, the subclavians, and the femorals in Hunter's canal are amenable to extirpation. As a rule arteries traversing tendinous regions give poorer results; the popliteals and the ulnar in its lower third; and those with many branches are not suitable for fear of interrupting collateral circulation already established.

When an obliteration is established, one is apt to consider only the mechanical interference with the peripheral circulation, merely thinking of the arteries as elastic tubes which carry the blood. Normally, the arterial wall changes every instant, and modifies the flow of blood by definite vasomotor reactions which are most marked in the arterial capillary system distal to the point of excitation. Since the arterial walls contain many nerve fibers which are sensory in nature, we find that changes in the chemical composition of the blood, physical distention of the artery itself, and various excitants cause reflex vasomotor reactions which control these peripheral vascular changes. We believe that they play an important rôle in the normal and pathological physiology of the blood.

It has been our experience that simple occlusion of the femoral artery without definite involvement of the adventitia, gives intermittent claudication as the major symptom, but in those cases in which the obliterative process involves the outer layers of the vessel, we usually find the later symptoms and signs of intractable pain, trophic ulceration, and gangrene. At the time of operation one almost always finds adhesions, thickening or induration of the tissues in the adventitial layer over an area of advanced thrombosis, and later microscopical examination verifies these observations. The obliterated femoral artery in thrombo-angiitis obliterans is thickened and larger than the usual small contracted vessel found in arteriosclerotic occlusion; this difference in size and appearance we have found to be quite constant at the operating table (Fontaine).

Hence, with the involvement of the adventitia the occluded artery ceases to be an artery, but becomes a diseased plexus of nerve fibers, which initiate peripheral vasospastic impulses by reflex action. It is this induced vasoconstriction of what might ordinarily be a sufficient anastomotic blood supply to an extremity, which eventually causes the marked signs and symptoms of cyanosis, severe pain, trophic disturbances, muscular hypotonia, and finally gangrene. In such cases we believe that arterectomy is indicated, for it does not change the mechanics of the established collateral circulation, but does eliminate reflex vasospasm initiated by the irritated and diseased sympathetic nerves in the arterial wall.

### CLINICAL PROCEDURE

In a patient who presents the signs and symptoms of arterial disease we try to evaluate the general condition by the usual examinations and tests with an idea of studying the extent of any generalized vascular condition present. Since arterectomy is applicable only to those cases in which a localized obliteration is complete, we then try to establish the location and extent of the occlusion accurately. Digital palpation of the arterial pulse affords one only a very rough idea as to location and the extent of an obliteration, but carefully recorded observations with the oscillometer do give more definite information. It was not until we employed routine arteriography, however, that we were able to establish and accurately visualize the extent of obliteration before operation. The importance of this accurate information cannot be overemphasized when we consider that each of the usual operative procedures which we have em-

ployed, namely, peri-arterial sympathectomy, arterectomy, lumbar or stellate ganglionectomy, ramisection, suprarenalectomy, etc., has its indication.

Our routine procedure (9), for visualizing the arterial system of an extremity, consists of inserting a fine, special lumbar puncture needle into the artery so that a good, spurting flow of blood is obtained as the stylet is withdrawn. The tubing leading from a small pressure tank is then connected, and the radio-opaque fluid under 2 to 3 kilograms of pressure is run into the artery. At a point where approximately 15 to 30 cubic centimeters have been injected at a steady rate of flow, the plate is taken. The fluid employed is "thorotrast" (a German compound of thorium), and in our experience, covering several years with many cases, we have had no serious accidents or complications. Occasionally, the patient suffers moderate discomfort for a minute or two when the injection is made with too much pressure, but this rapidly disappears and the majority of arteriographs are entirely without pain. Recently, several serious accidents have been reported in France where this procedure is widely employed, but in all these cases the injection fluid was an iodine compound of French manufacture, which experiments in the past have shown to be unsatisfactory for arterial injection. In spite of the fact that thorium is practically not eliminated by the human body, we have seen no ill effects even when it has been employed in cases with early gangrene.

With such exact information as the arteriograph affords we are now prepared to offer intelligent operative treatment when it is indicated. The technique of arterial resection is usually not difficult, but we wish to emphasize that the more extensive the resection of an obliterated artery (for example, 15 to 20 centimeters of the femoral artery), the finer the results will be. The patient is encouraged to walk as soon as the wound is sufficiently healed, and we find that the average stay in bed is from 10 to 15 days.

## FOLLOW-UP STUDIES

In our attempt to evaluate accurately the operation of arterectomy in the treatment of arterial occlusions we have selected 60 consecutive cases, representing 78 arterectomies performed. All of these patients were seen over 1 year, the majority more than 3 years, and a few up to 10 years after operation. For most of this data we are indebted to Dr. Saldriga, a member of our clinic in Strasbourg, who personally carried out these follow-up studies.

We have grouped the results under five headings:

1. *Very good*—when a patient is able to carry on normally his daily occupation, suffering only occasional symptoms of mild intermittent claudication, or when completely asymptomatic.

2. *Good*—when there is a complete disappearance of all cyanosis, edema, or ulcerative lesions, but when intermittent claudication alone remains.

3. *Apparent improvement*—when there has been a temporary relief of symptoms for a period of at least 6 months, then followed by exacerbation of signs and symptoms.

4. *Poor results*—when there was no relief of symptoms.

5. *Unknown results*—when the patient failed to report for follow-up examination.

The pathological conditions for which arterectomy was performed, are as follows: (also, see Table I).

| | Cases | Operations |
|---|---|---|
| Thrombo-angiitis obliterans | 27 | 34 |
| Senile arteriosclerotic occlusions | 22 | 33 |
| Syphilitic occlusions | 2 | 2 |
| Embolic occlusions | 3 | 3 |
| Traumatic occlusions | 6 | 6 |

## DISCUSSION OF RESULTS

That the operation of arterectomy is not a serious surgical procedure, and is well tolerated by patients, who, as a rule, are not the best surgical risks, is shown by the fact that there were no fatalities or serious complications in this series. Of the two major groups we note the best results (*good* and *very good*) in the arteriosclerotic type of arterial occlusion, where we find 54.5 per cent of the patients definitely relieved of symptoms for a period of years. The thrombo-angiitis group, in about the same number of operations, produced only 35 per cent of satisfactory results.

TABLE I.—TABULATION OF FOLLOW-UP RESULTS BY OPERATION

| | Number of operations | Very good | | Good | | Temporary | | Poor | | Unknown | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent |
| Thrombo-angiitis obliterans | 34 | 6 | 17.5 | 6 | 17.5 | 7 | 20.7 | 10 | 29.5 | 5 | 14.8 |
| Arteriosclerosis | 33 | 8 | 24.2 | 10 | 30.3 | 8 | 24.2 | 2 | 6.0 | 5 | 14.3 |
| Syphilis | 2 | | 0 | | 0 | | 0 | 2 | 100 | | 0 |
| Embolus | 3 | | 0 | | 0 | | 0 | 3 | 100 | | 0 |
| Traumatic | 6 | | 0 | 4 | 66.0 | | 0 | 2 | 33.0 | | 0 |
| Total | 78 | 14 | 17.9 | 20 | 25.7 | 15 | 19.3 | 19 | 24.3 | 10 | 12.8 |

In each of these groups we must remember that patients representing 5 operations, or 15 per cent, failed to return for follow-up examination. It is only fair to assume that some of these represent satisfactory results, also. In passing, we note the 2 failures in supposed syphilitic occlusions, but also wish to emphasize that the 3 embolic failures occurred in unfavorable cases in which operation was delayed and gangrene had already set in. Ordinarily, if a case of embolism is seen early, we are convinced that arterectomy probably combined with ganglionectomy, holds a definite hope for saving a limb, often when embolectomy has failed. Our best results in traumatic cases were those in which a fibrosed arterial cord could be resected, with subsequent relief of pain, cyanosis, and edema.

## SUMMARY AND CONCLUSIONS

We are convinced, both from experimental studies and from our follow-up statistics in a series of 78 consecutive operations, that arterectomy deserves a definite place in the treatment of localized arterial obliterative disease. We do not advocate it as a certain cure for early or impending gangrene, but we have had a good percentage of satisfactory results with relief lasting over a period of years. Since lumbar sympathectomy carries a mortality of 4 per cent or more, arterectomy, with its minimum surgical risk, should be the operation of choice in a majority of patients. While we have not had the occasion to combine this operation with further non-operative treatment to improve collateral circulation, we believe that subsequent treatments with the Pavaex unit of Reid and Hermann, or heat, massage, and exercises may supplement arterectomy to give a greater percentage of fine results.

The operation of arterectomy in the treatment of localized arterial obliteration has been employed and studied in our clinic since 1917. The literature is reviewed.

Experimentally we have demonstrated in dogs that:

1. Multiple resections of the main arterial trunks of both limbs including the aortic bifurcation, are well tolerated.

2. A more extensive and quicker collateral circulation is established by resection than by arterial ligation.

3. Massive arterial resections including the aortic bifurcation, in one stage, are well tolerated, and leave no demonstrable after-effects only when lumbar sympathectomy is done in a preceding operation.

Arterectomy is indicated in localized arterial occlusion of the extremities caused by senile arteriosclerosis, trauma, freezing, after surgical ligature, and in favorable cases of embolus and thrombo-angiitis obliterans.

We believe that an obliterated artery functionally ceases to be an artery, but becomes a diseased plexus of sympathetic nerve fibers provoking distal vasospasm in the anastomotic network of vessels.

Our observations indicate that simple, progressive occlusion of an artery causes intermittent claudication, whereas cyanosis, edema, trophic ulceration, and gangrene usually occur in arterial obliterations in which the adventitia, also, is definitely involved in the pathological process.

Routine arteriography with thorotrast affords one a definite picture of the location and extent of an arterial occlusion, and is essential

in the intelligent application of arterial resection.

Follow-up studies on 60 consecutive cases, representing 78 operations with no fatalities, show a definite relief of symptoms of from 1 to 10 years' duration in 43.6 per cent of all cases; 54.5 per cent of the senile arteriosclerotic obliterations; and in 35 per cent of the cases of thrombo-angiitis obliterans; with 15 per cent unknown results.

Although arterectomy has not produced as large a percentage of satisfactory results as those reported for lumbar sympathectomy, because of its minimum surgical risk, it deserves a definite place in the active treatment of obliterative arterial disease.

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# THE CLINICAL USE OF CYCLOPROPANE[1]

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THE anesthetic properties of cyclopropane were discovered by Henderson and Lucas of Toronto, but the first clinical investigation of this agent was that of Waters and his associates at the University of Wisconsin.

## PROPERTIES

Cyclopropane is a cyclic hydrocarbon gas with the empirical formula $C_3H_6$. Structurally it is the smallest cyclic compound possible, having only three carbon atoms, $H_2C\overset{CH_2}{\triangle}CH_2$ and is isomeric with propylene. As one would expect from its cyclic structure it is rather inert. This gas has a molecular weight of 42.063, and a density of 1.46 compared with air. Therefore, when released, it will have a tendency to sink to the floor as does ether vapor, while ethylene with a density of 0.975 has a tendency to diffuse in all directions. The pressure at which this gas liquefies is quite low as compared with other anesthetic gases. It is marketed in cylinders under a pressure of 75 pounds per square inch; nitrous oxide tank pressure is 800 pounds, while that of ethylene is 1250 pounds. One ounce of the gas is equivalent to approximately 4.29 gallons.

Cyclopropane is only slightly soluble in water, but is much more soluble in oil. The oil to water ratio of solubility as given by Henderson and Lucas is 64.4:1, while that for ethylene is 13.2:1, and ether 2.5:1. This gas in a concentrated form causes deterioration of rubber if left in contact with it for any length of time. Therefore, any machine used for the administration of cyclopropane should have all metal valves. This solvent property for rubber is not manifested in the low concentration in which the gas is present in an anesthetic mixture.

Cyclopropane is inflammable, and, when mixed with oxygen, may form an explosive mixture. The limits, expressed in percentage by volume of explosibility of cyclopropane-air and cyclopropane-oxygen mixtures as given by Buckman and Wardell are as follows:

| | Lower limit | Upper limit |
|---|---|---|
| Cyclopropane and air | 3.0 | 8.5 |
| Cyclopropane and oxygen | 2.5 | 50.0 |

It is evident, therefore, that the average anesthetic mixture (about 15 per cent) is well within the explosive range. In this respect it is quite different from ethylene, for with that gas most anesthetic mixtures (containing probably 80 to 85 per cent ethylene) are above the explosive range. Precautions for the prevention of explosion will be discussed later.

## PHARMACOLOGY

Absorption of cyclopropane through the lungs is quite rapid, and unconsciousness is usually reached in 1 to 2 minutes. Complete equilibrium and saturation are slowly reached, and it is sometimes necessary to maintain a slow flow of gas (50 to 100 c.cm. per minute) for 10 to 20 minutes after the patient has reached a sufficient depth to allow the operation to begin. The probable explanation for this slow saturation lies in the high oil to water solubility ratio of this gas, hence the very rapid absorption by the lipoids of the body.

Elimination from the blood is probably quite rapid as consciousness very quickly returns after the mask is removed (usually in 2 to 10 minutes). That complete elimination is not effected for a considerable time was shown by Waters and his associates (18). They were able to demonstrate measurable quantities of the gas in the subcutaneous tissue of the back of animals several hours after the administration of cyclopropane had been discontinued.

In high concentration (50 per cent or more) cyclopropane is quite irritating to the respira-

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tory passages, and, if breathed in this concentration may cause laryngospasm.

Cyclopropane does not have the respiratory stimulating effect which is so evident with nitrous oxide and ethylene, and the fact that frequently the respiratory rate becomes considerably slower, or even that a period of apnea may develop soon after administration is begun would tend to indicate that it may be a slight respiratory depressant. This phenomenon is more frequently noted when the patient has had a rather large dose of a respiratory depressant sedative such as a barbiturate or morphine. All experimental workers who have purposely administered this gas in fatal concentration to lower animals agree that respiration ceases well before circulation fails (14, 16, 17).

It has been the observation of many workers with this gas that gross pulse irregularities are not at all infrequent. These irregularities are usually noted as anesthesia of considerable depth is reached and the concentration of the gas is quite high. Kurtz, Bennett, and Shapiro carried out electrocardiographic studies on patients under several common anesthetic agents including cyclopropane. They found that some type of irregularity with all agents was much more frequent than was previously supposed. In their series of 113 surgical operations on 109 patients, 79 per cent showed cardiac irregularities. Some type of irregularity was demonstrated in 46 per cent of the cases under procaine, 82 per cent of the cases under cyclopropane, 90 per cent of the cases under ether, and 100 per cent of those under chloroform anesthesia (only 6 cases). The 3 most common irregularities noted were: (1) extrasystoles of various origins (this was the predominating arrhythmia with cyclopropane); (2) displacement of the pacemaker; and (3) sinus arrhythmia. Thirty-one of the patients in this series of cases exhibited some type of circulatory abnormality before operation was done.

Multiple focus ventricular tachycardia occurred in 4, or approximately 10 per cent of the cyclopropane cases. Since this type of arrhythmia occurred in 4 cases of 109, and since all of these occurred with cyclopropane, certainly further investigation is needed as to the effect of this anesthetic agent on the circulatory system. The importance of this is seen to be very great when it is remembered that it was this type of arrhythmia which Seevers, Meek, Rovenstine, and Stiles noted immediately preceding fatal ventricular fibrillation in 2 dogs to which they had administered extremely high concentrations of cyclopropane.

The effect of cyclopropane on blood chemistry is very slight. There is a slight rise in blood sugar, as is true with most anesthetic agents, but the level very quickly returns to normal, and there is practically no change in the acid base balance.

Raginsky and Bourne have studied the effect of this gas on both the normal and the damaged liver, and have found that the liver is in no way impaired even by repeated administrations of cyclopropane.

## USES

The combination of quiet respiration, ease of induction, and potency, together with an adequate oxygen supply makes this anesthetic suitable in almost any situation in which an inhalation anesthetic is desired. These factors combined with a relatively low toxicity leave very few contra-indications to its use. Its advantages are most outstanding under the following conditions:

1. *When excess oxygen is of value.* a. *Thoracic surgery.* The increased oxygen in thoracic surgery is frequently of great benefit since many of these patients are in a rather markedly debilitated state and in addition their lung tissue is usually damaged thus causing a decrease in absorptive surface. These conditions combined with the necessary position of the patient on the operating table causing the respiratory excursion to be greatly limited make the maintenance of anesthesia without anoxemia under the less potent drugs, such as nitrous oxide and ethylene, very difficult and in some instances practically impossible.

b. *Hyperthyroidism.* The increased metabolic rate of these patients makes quite obvious the advantage of an anesthetic agent which insures an abundant oxygen supply at all times.

*c. Respiratory obstruction.* In any case in which the adequate exchange of gases is impaired by any type of respiratory obstruction, an anesthetic which is sufficiently potent to be efficacious in low concentration and at the same time carry with it a large supply of oxygen is of great value.

*d. Cardiac disease.* The use of cyclopropane in the presence of a serious cardiac lesion is certainly debatable in view of our present knowledge of its effect on the circulatory system. We feel that it is the anesthetic of choice for these cases if deep anesthesia (third plane) is not required for the surgical procedure anticipated. However, the circulation should be watched very closely in these cases, and any change such as a drop in blood pressure, the development of an arrhythmia not present before the anesthesia or any considerable change in pulse rate should be a signal for immediate lightening of the anesthesia by the addition of oxygen.

*e. Anemias.* In patients suffering from anemia with the consequent decreased oxygen carrying capacity of the blood, the value of an anesthetic agent of such strength that increased oxygen supply is possible, becomes quite evident.

*f. Debility and shock.* Before the advent of cyclopropane we ordinarily used local anesthesia on patients markedly weakened by shock or other causes, because we felt that the administration of the general anesthetics then available, put too much of a burden on them. Now, however, we feel that we can safely give them cyclopropane because of its low toxicity and because of the high beneficial concentrations of oxygen that may be used with it. Moreover, this adds to the comfort of the patient and facilitates the work of the surgeon.

*2. When intratracheal anesthesia is necessary.* The complete abduction of the vocal cords which cyclopropane anesthesia usually affords, makes it a very valuable agent for the introduction of an intratracheal tube.

*3. When general anesthetics must be supplemented.* Cyclopropane may be used as ether has been used in the past to supplement either ethylene or nitrous oxide, when either of these agents is not sufficiently potent to maintain adequate depth of anesthesia without anoxemia. The use of cyclopropane as a supplement to either of these agents will, of course, likely result in an explosive mixture. In the case of ethylene the addition of any considerable amount of cyclopropane to the mixture will necessitate an increase in the amount of oxygen which is being administered, and as a result the ethylene-oxygen mixture may reach a concentration that is explosive. In the case of nitrous oxide this is because a reducing agent, cyclopropane, is added to two oxidizing agents, nitrous oxide and oxygen.

*4. When spinal anesthesia must be supplemented.* There are many conditions which may arise during the course of spinal anesthesia in which cyclopropane is of great value. In our experience those in which it has proved itself of value are the following:

*a. Insufficiency of spinal anesthesia.* This insufficiency of spinal anesthesia may be due to (1) insufficient height—the anesthetic drug fails to reach a segment in the spinal cord high enough to render anesthetic the field in which the operation is to take place. (2) Insufficient sensory effect—with the use of very dilute drugs for spinal anesthesia, such as a 1:1500 solution of nupercaine, an occasional case will be encountered in which, although the patient has sufficient motor relaxation for the operative procedure, sensation is not completely abolished. (3) Insufficient duration—if for any reason the operation is of longer duration than anticipated there is always the danger that the operation will outlast the anesthesia.

*b. Retching and vomiting.* During the course of spinal anesthesia, retching and vomiting may be so persistent that the work of the surgeon becomes extremely difficult. Practically the only efficacious method of alleviating this condition is by the administration of a general anesthetic.

*c. Discomfort from oxygen administration.* When for any reason during the course of spinal anesthesia the administration of oxygen is indicated, the addition of a small amount of cyclopropane (just enough to insure unconsciousness) is of great value in alleviating discomfort to the patient from the pressure and the sense of suffocation caused by the face mask. This is particularly true if the patient is restless or nervous.

*d. Nervousness and apprehension.* It is often necessary to render unconscious the very nervous, anxious, or apprehensive patient.

In all of these conditions in which a supplement to spinal anesthesia is of value, we have found cyclopropane much superior to any other agent. The properties of this gas which render it particularly adapted to these cases are its potency, making it possible to give large amounts of oxygen, and the smoothness with which induction is accomplished. Usually we are able to anesthetize the patient with cyclopropane for any of the reasons given without any change whatsoever in the respiratory rate or volume, in fact the surgeon seldom is aware that a supplementary anesthesia is being used.

*5. When operation is short and considerable relaxation is required.* For such procedures as orthopedic manipulations, setting of fractures (not in presence of an x-ray machine), and pelvic examinations, cyclopropane anesthesia is very useful.

*6. In abdominal surgery.* Since we almost always use spinal anesthesia for abdominal operations, we are not in a position to evaluate cyclopropane for this type of surgery. We do feel, however, that the additional relaxation without anoxemia which cyclopropane affords, as compared to ethylene and nitrous oxide will be greatly appreciated by surgeons who have been used to doing abdominal work under these last two anesthetic agents. On the other hand, surgeons who are accustomed to spinal anesthesia will probably not be so pleased with the relaxation which cyclopropane affords. Cyclopropane stands between ethylene and ether in the degree of abdominal relaxation it produces. Perhaps it more nearly approaches the relaxation of ether.

*7. In obstetrics.* Bourne, Griffith, Marvin, and Saklad, all report very favorably on the use of cyclopropane in obstetrics, for intermittent administration to relieve labor pains and for manual and instrumental delivery, as well as for the cesarean operation. They report satisfactory working conditions for the surgeon, relatively low toxicity for the mother, and the very infrequent necessity for the use of any type of resuscitative procedure for the baby.

We have had no experience with cyclopropane for any type of obstetrical procedure, but we would certainly expect that it would be particularly suited for this type of work, because of the large amount of oxygen which may be administered with it and because of its rapid, smooth induction.

### PRELIMINARY MEDICATION

For cyclopropane anesthesia it is desirable to have the patient arrive in the operating room quite drowsy (though not sound asleep), free from any worry or anxiety concerning his proposed operation and without any degree of respiratory depression. Unfortunately, in a great many cases this ideal is very difficult to attain. Because of the lack of respiratory stimulation of cyclopropane, failure to attain the ideal as regards respiratory depression introduces a difficulty in administering this agent that would not be present in administering nitrous oxide or ethylene. Occasionally patients who have had rather heavy pre-operative medication develop apnea during induction. This period of apnea usually appears before sufficient depth has been reached to allow the operative procedure to begin. This condition necessitates artificial respiration by means of pressure on the breathing bag, or considerable stimulation with carbon dioxide which we feel may be harmful if continued for any great length of time. On the other hand if we choose the extreme of giving no pre-operative medication or only a nominal amount, we must give a higher concentration of the gas, especially during induction. This may well constitute an additional hazard, since it was in cases of this type that Waters noted the more frequent occurrence of pulse irregularities during induction.

We have attempted to strike a medium with pre-operative narcosis, giving enough to obtund the sensibilities of the patients, even if not enough to make them actually drowsy, and at the same time endeavoring to keep the pre-operative sedation low enough to insure, at least in most cases, that there will be no respiratory depression. Our average medication before operation for a young or middle aged adult in relatively good condition is 1½ grains of nembutal (pentobarbital sodium)

administered orally 1¼ hours before operation, and ⅛ to ⅙ grain of morphine sulphate with 1/150 grain of scopolamine hydrobromide administered subcutaneously ¾ of an hour before operation.

Wood gives a very favorable report on the use of a basal dosage of tribromethanol (avertin) followed by cyclopropane. He thinks that cyclopropane anesthesia tends to be smoother when this basal anesthetic is used. He feels that the morbidity is less, and states that he is not troubled with respiratory depression. This is a time consuming procedure, and entails the addition of another agent which we feel carries within itself certain hazards; therefore, we have not felt justified in adopting it routinely. We have, however, used this technique occasionally on patients who were particularly apprehensive or nervous (as in severe thyrotoxicosis) and have been quite well pleased with the results.

### CONDUCT OF ANESTHESIA

Cyclopropane may be administered by means of any gas machine that is equipped for the carbon dioxide absorption technique. On our older machines which are not equipped with a yoke for cyclopropane we have found it convenient to use the carbon dioxide yoke as the rate of flow of this gas is practically the same as that of carbon dioxide, hence no correction of the reading is necessary. As a precaution against explosion as well as from an economical standpoint, the carbon dioxide absorption technique is the only one that is adapted for the use of cyclopropane (20).

The anesthetist accustomed to nitrous oxide and ethylene, who is using cyclopropane for the first time, would do well to bear in mind the fundamental difference between these two types of anesthesia. With nitrous oxide or ethylene, an attempt is made to administer as high a concentration of gas as possible by flushing out repeatedly the machine and lungs in order to get rid of as much of the diluting nitrogen as possible. With these gases oxygen is added in as small amount as possible, in an attempt to keep the patient reasonably free from anoxemia (and not always succeeding). On the other hand with cyclopropane anesthesia the patient is breathing an atmosphere very high in oxygen to which only a sufficient amount of the anesthetic agent is added to induce and maintain anesthesia. With cyclopropane it is not necessary to flush out the lungs and machine in order to have sufficient gas for anesthesia and sufficient oxygen in the system to prevent anoxemia.

*Induction.* There are perhaps as many variations in the technique of induction of cyclopropane anesthesia as there are users of the gas. We shall give here only an outline of the technique which we have employed for some time and which has proved very satisfactory. Our inductions are usually started with the soda lime excluded from the breathing circuit, it is switched in to the circuit later at any time during induction that breathing becomes sufficiently stimulated to indicate an accumulation of carbon dioxide. To start induction, enough oxygen is run into the breathing bag to satisfy tidal respiration (about 500 to 1000 c.cm.), the mask is placed on the face, and a flow of 1000 cubic centimeters per minute of oxygen and 200 cubic centimeters per minute of cyclopropane is started. The flow of cyclopropane is increased by 100 cubic centimeters increments until a flow of 500 cubic centimeters per minute is reached, allowing the patient to take at least 2 breaths after each increase in flow before it is again increased. This gradual addition of cyclopropane is to guard against any irritation to the respiratory tract from too high a concentration of the gas. The oxygen flow is now decreased to 500 cubic centimeters per minute, and the induction is continued with cyclopropane and oxygen each flowing at the rate of 500 cubic centimeters per minute, until sufficient depth has been reached to allow the operation to begin. This usually requires 2 to 3 minutes. The oxygen flow is now reduced to the estimated metabolic requirement (usually 200 to 400 c.cm. per minute), and the cyclopropane flow is decreased to the rate of 50 to 100 cubic centimeters per minute at which level it may be left for 10 to 20 minutes or until sufficient equilibrium is established to allow it to be turned off completely. This continued flow of cyclopropane is frequently not necessary, but in many cases it will prevent the embarrassing situation of having a patient start coughing

or moving 5 to 10 minutes after the operation has started.

*Maintenance.* As stated, it is frequently necessary to maintain a small flow of cyclopropane for the first 10 to 20 minutes of anesthesia in order to establish an equilibrium between the tissues of the body, the blood, the lungs, and the machine. From this stage cyclopropane or oxygen may be added as needed. A simple method for increasing slowly the depth of anesthesia after saturation has been reached is to turn the oxygen flow completely off for a short while, and as the patient slowly uses the oxygen in the system to satisfy his metabolic needs the concentration of the gas is, of course, increased, and the patient's depth of anesthesia is increased. It is well to delay the insertion of either nasal or oral breathing tubes until quite sure that the patient is sufficiently deep to obviate any danger of a reflex laryngospasm. It is thought by some that stridor is more likely to occur with cyclopropane than other gases. We feel that this is usually due to simple obstruction caused by greater relaxation under this gas. In some cases, however, this may be due to spasm perhaps from some local irritant such as a breathing tube, mucus, or too high a concentration of cyclopropane for a moment during induction.

Toward the close of the operation the bag may be emptied and an oxygen flow of 500 to 1000 cubic centimeters per minute started to assist in as rapid a recovery as possible.

*Recovery.* The return of consciousness is quite rapid (2 to 10 minutes) compared with ether, but it is possibly a little slower than with ethylene or nitrous oxide. The rapid return of consciousness and of the cough reflex is a distinct advantage in many cases. While consciousness very quickly returns, complete elimination of the gas probably does not take place for several hours.

It is to the excellent report of Schmidt and Waters of the morbidity in 2200 cyclopropane anesthesias that we owe much of our accurate knowledge concerning postoperative complications following cyclopropane anesthesia. They reported fewer respiratory complications with this gas than with other general anesthetic agents. Nausea and emesis were not as frequent in major procedures with cyclopropane as with other agents, but in short procedures there was a greater incidence of nausea and emesis with cyclopropane than with the other agents. Our clinical impression is in accord with both of these findings.

As to circulatory complications, Schmidt and Waters reported a slightly higher incidence with cyclopropane than with the other anesthetic agents, namely ethylene, nitrous oxide, and ether. However, they qualified this statement, and stated that further study was needed. Dr. Waters and his associates in their statistical report from the department of anesthesia at the State of Wisconsin General Hospital for 1935 report a considerably lower incidence of circulatory complications with cyclopropane anesthesia than they do with ether or ethylene and slightly higher than with nitrous oxide. Although we do not at this time have statistics available concerning postoperative circulatory complications, it is our clinical impression that there is no higher incidence of these with cyclopropane than with the other anesthetic agents.

### SIGNS OF DEPTH

The sign posts signifying the depth of anesthesia are perhaps not as clearly marked with this gas as with ether. This is particularly true if the induction is rapid. The rapidity with which unconsciousness and even deep surgical anesthesia is reached with this gas renders the lines of demarcation between the different stages very indefinite, each stage fading into the next. It is our impression, however, that within reasonable limits, in most cases, the particular depth at any time can be fairly well ascertained, and that the various signs of depth as outlined by Guedel can be depended upon, if induction is fairly slow and the patient is carefully watched.

The first and second stages are usually very rapidly passed through, and in most instances there is no stage of excitement. We have usually used the absence of the wink reflex when the eyelashes are touched as marking the transition from the second to the third stage, or surgical anesthesia. Movements of the eyeball are usually very slow, and the eyes must be observed for a considerable time in

order to note any movement at all. Frequently we feel that this sign is of no value and it may be entirely absent. It has also been our observation that the cessation of movements of the eyeball, marking the transition from the first to the second plane of the third stage of anesthesia, usually means that they will thereafter be entirely fixed and will not move again even though the anesthesia is lightened sufficiently that such gross muscular movements as that of an arm or leg may take place.

As the depth of anesthesia progresses toward the third plane of surgical anesthesia, the pupil usually begins to dilate. As this depth is reached a very careful watch of the patient for any untoward signs should be rigorously kept, as it is with the higher concentrations of this gas that circulatory disturbances are more likely to occur. Particularly should the patient be watched for any marked change in the pulse rate, any considerable change in blood pressure, or any irregularity of the pulse that was not present before anesthesia was started. The occurrence of any of these changes should be a signal for an immediate lightening of the anesthesia by increasing the oxygen percentage in the inhaled mixture.

With cyclopropane, as with other anesthetics, there is no single infallible sign of depth of anesthesia which can be depended upon at all times. We do, however, feel that perhaps the most reliable signs are those demonstrated by the respiratory system. It is our clinical impression (although this has not been demonstrated by minute volume respiratory readings) that from the onset of surgical anesthesia to respiratory paralysis, there is a progressive decrease in respiratory excursion, and frequently a decrease in the respiratory rate, so that any marked change in the direction of decreased excursion or of lowered rate should be the signal for an immediate checking of anesthetic depth. Perhaps the best and certainly the safest check for this is an immediate increase in the oxygen concentration. As depth progresses to the transition from the second to the third plane of surgical anesthesia, there is a definite decrease in intercostal respiratory activity with a consequent increase in abdominal activity very similar to that which occurs with ether anesthesia. As with the eye signs, however, these transitions or stages are not as definite as they are with ether anesthesia, particularly if induction and deepening of anesthesia occur rather rapidly.

### DANGERS AND PRECAUTIONS

The most likely site of damage from cyclopropane anesthesia is the circulatory system, and it is to this system, therefore, that the closest attention should be paid. The appearance during anesthesia of any change such as marked decrease or increase in the pulse rate, or any irregularity not present before the anesthesia started, or any sudden drop in blood pressure, or narrowing of pulse pressure should be a signal for immediate lightening of the anesthesia.

It has been the observation of all who have worked with this gas, either clinically or experimentally, that the respiratory system always fails some time before the circulatory system fails. This property places cyclopropane in the group of safe anesthetics.

The fact that this agent will produce anesthesia in concentrations even below 10 per cent calls for extreme caution in its use. Obviously a gas that is anesthetic in such low concentration may be given in sufficiently large quantities to produce untoward effects on a patient even in the presence of adequate or even excess alveolar oxygen. With this gas the warning sign of cyanosis is not present as it is with nitrous oxide or ethylene.

Since anesthetic mixtures with cyclopropane all fall directly in the explosive range, we feel that adequate precautions should be taken to prevent explosion. The most important of these is the administration of the anesthetic by an entirely closed system, which of course necessitates the carbon dioxide absorption technique (20). Extreme care should be taken with each case to insure the absence of any leak in the system. As was stated before, the fairly high specific gravity (1.46) of this gas causes it to fall toward the floor, as does ether vapor when allowed to escape. This is in marked contrast to the action of ethylene, for that gas, with a specific gravity of 0.975 diffuses in all directions. When cyclopropane is mixed with 4 to 6 times its volume of oxygen,

it, of course, becomes much lighter and hence more diffusible. The maintenance of relative humidity of 55 per cent or more in the operating room is a valuable precaution against the danger of ignition by static charges of electricity. We feel an additional factor of safety is introduced by having the gas machine, operating table, patient, and anesthetist electrically connected, but this system is not grounded to the outside. It is our opinion that high frequency electrical apparatus should not be used in the operating room in which cyclopropane is being administered as we know of no method that will surely control sparking at any number of scattered points in the vicinity of such an apparatus. This, of course, includes x-ray apparatus as well as electrosurgical units, both for cutting and coagulation. On the other hand, however, we do not look upon the low voltage actual cautery as being a source of danger if used at considerable distance from the face of the patient such as for cauterization of the cervix uteri or of hemorrhoids. We even permit its use in intestinal surgery if there is a vertical screen between the mask and the field of operation. We do, however, take the added precaution of covering the patient's face and all points on the gas machine at which a leak is likely to occur, with a wet towel.

### COST

Though the cost per gallon of this gas seems quite high (about 30 cents current market price) the actual cost per anesthesia is very low. The cost per hour of anesthesia certainly does not run over 25 cents for the gas alone. This estimate allows for a certain amount of leakage, and of course presupposes the use of the carbon dioxide absorption technique in an entirely closed system.

### PRESENT STATUS OF CYCLOPROPANE ANESTHESIA

We feel that various workers have used this gas in a sufficiently large number of cases, that the benefits are sufficiently great, and that the dangers are sufficiently few, to warrant a statement at this time to the effect that this agent has established for itself a very definite place in the anesthetist's armamentarium. While it has certain disadvantages, and considerable more investigation particularly of its effect on the circulatory system is needed, it is more nearly approaches the ideal inhalation anesthetic than any other drug which is available at the present time. As an example of the place that it has taken in the Lahey clinic, the following figures may be of value. The number of cyclopropane administrations has increased from a mere 57 cases in 1933 (first used in the fall of that year) to 553 administrations in 1934, which represents 13.3 per cent of the total number of anesthetics administered and 18.1 per cent of the total inhalation anesthesias, to a total of 1437 administrations in 1935, which represents 34.1 per cent of the total number of anesthesias and 54.5 per cent of the inhalation anesthesias. A glance at our records for the current year (1936) indicates that these figures will be surpassed. This increase in the percentage of cyclopropane cases has been largely at the expense of ethylene, ether, local, and regional, and to a certain extent of nitrous oxide anesthesia (although this drug has been very infrequently used for several years).

### SUMMARY

The combination of low toxicity, rapidity of action, and considerable power even when mixed with a surplus of oxygen makes cyclopropane occupy a unique position among the general anesthetics. Its use is particularly advantageous for obstetrical procedures, for operations for which moderate relaxation is desired, for intratracheal anesthesia, for supplementing other anesthetics, both general and spinal, and for the several varieties of cases in which an abundant supply of oxygen is desirable. The chief toxic effect appears to be a temporary disturbance of the heart, usually evident only under the deeper stages of anesthesia. The cost of cyclopropane administration is low.

The signs of depth of anesthesia are roughly parallel to those of the other inhalation anesthetics. The technique of administration is radically different from that of nitrous oxide and ethylene. This gas represents another step toward the ideal anesthetic agent, and is usurping portions of the fields of all other anesthetics.

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# MECHANISM OF RELIEF OF PAIN IMMEDIATELY AFTER TOTAL THYROIDECTOMY FOR ANGINA PECTORIS AND CONGESTIVE FAILURE

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TOTAL ablation of the thyroid gland in patients with angina pectoris and chronic passive congestion frequently produces immediate postoperative relief of pain preceding and distinct from the lasting relief due to the development of hypothyroidism. Previous investigations (11) have shown that this early relief of pain cannot be attributed to changes in the amount of circulating thyroxin, for it appears before alterations in the basal metabolic rate can be detected, and persists for days or weeks when the basal metabolism is maintained at the pre-operative level by thyroid medication. Moreover, it was found that when only one lobe of the thyroid was removed, relief of pain was experienced solely on the side from which the thyroid lobe was removed. These observations suggested that the early relief was due to injury of afferent nerves from the heart, incidental to the total ablation of the thyroid gland. Regeneration of these fibers, or development of accessory pathways, would account for the return of pain after several weeks. The similarity of the early relief afforded by total thyroidectomy to the results obtained in angina pectoris by the surgical removal of the superior cervical ganglion (4), is in accord with such a hypothesis.

The purpose of this communication is to present additional clinical observations regarding the early postoperative relief of pain and to report the results of anatomical studies relating to this problem.

## CLINICAL OBSERVATIONS ON THE IMMEDIATE RELIEF OF PAIN

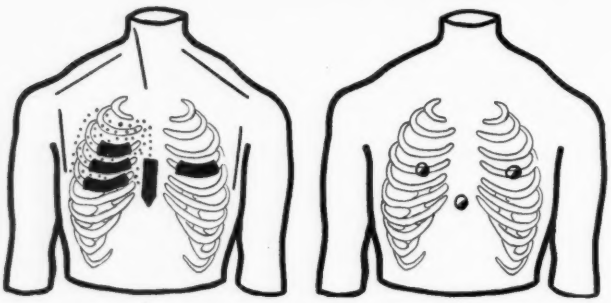
To determine with greater accuracy the time of onset of early relief of pain following total thyroidectomy, observations were made at frequent intervals during and after operation. Three patients were chosen in whom definite areas of bone and muscle tenderness and skin hyperesthesia were constantly found on repeated examination by various observers. The night before the operation these areas were mapped out on the skin with indelible ink, and immediately before operation hyperesthesia and hyperalgesia were found to conform accurately to the areas outlined, despite light pre-operative sedation. The areas of hyperalgesia and muscle tenderness were reexamined during the course of operation: (1) after the skin of the neck was injected with novocain and incised; (2) after the sternothyroid and sternohyoid muscles were severed; (3) after the upper pole of the thyroid gland was injected with novocain; (4) after the lateral thyroid vein was ligated; (5) after the superior thyroid vessels were divided; (6) after the inferior thyroid vessels were divided; (7) after the lobe of the thyroid was removed from its bed. Observations were repeated immediately after the operation and daily during the patient's stay in the hospital.

The results are shown in the following case reports:

CASE 1. Rheumatic heart disease, angina pectoris. Loss of hyperalgesia of chest after severance of right inferior thyroid vessels during removal of right lobe of the thyroid gland.

R. S., a male, 41 years of age, was admitted to the hospital with the diagnosis of mitral stenosis and regurgitation, aortic insufficiency, coronary thrombosis, and angina pectoris. On November 28, 1933, the left lobe of the thyroid gland was removed under local novocain anesthesia, by Dr. Charles G. Mixter. At the time of the first examination 2 hours after hemithyroidectomy, hyperalgesia and muscle tenderness of the chest were found to be absent. After 2 weeks there was a gradual return of hyperesthesia and hyperalgesia until all signs had returned to their pre-operative level.

From the Medical Research Laboratories of the Beth Israel Hospital and the Department of Medicine, Harvard University Medical School. This investigation was aided by a grant from the William W. Wellington Memorial Research Fund of Harvard University.



A B

Fig. 1. Case 1. A, Before right hemithyroidectomy. B, During operation, after ligation of inferior thyroid vessels.

On March 22, 1934, the right lobe of the thyroid gland was removed under local novocain anesthesia. The pre-operative distribution of skin hyperesthesia, bone and muscle tenderness is indicated in Figure 1, A. Immediately after ligation and severance of the right inferior thyroid vessels, pain, previously elicited by pressure over the ribs or by pinching muscles, completely disappeared. The patient noted a dull ache over the three spots indicated on Figure 1, B. Immediately after operation re-examination corroborated these findings and revealed that skin hyperesthesia over the right thorax had also disappeared. These findings were checked by several observers repeatedly during the week after operation.

CASE 2. Rheumatic heart disease, mitral stenosis and insufficiency, congestive failure, bronchiectasis. Loss of hyperesthesia and hyperalgesia of the chest after freeing lobes of thyroid gland from their bed.

F. F., a female, aged 35 years, was admitted to the hospital with the diagnosis of mitral stenosis and insufficiency, congestive failure, and bronchiectasis showing hyperesthesia and hyperalgesia of the chest as is indicated in Figure 2, A. There was no change in these findings until after the right lobe was freed from its bed (Fig. 2, B), when pressure on the ribs of the right thorax failed to give rise to pain reaction. Hyperalgesia of the ribs on the left was unchanged until after the left lobe was removed from its bed (Fig. 2, C). After operation hyperesthesia of the skin of the right anterior thorax was also found to be absent.

CASE 3. Rheumatic heart disease, mitral stenosis and insufficiency, aortic insufficiency, auricular fibrillation, cardiac decompensation. Loss of hyperalgesia of muscle tenderness of the chest 2 hours after left hemithyroidectomy. Return of signs in 1 month. Loss of hyperalgesia and muscle tenderness after injection of right stellate ganglion with novocain.

H. K., a female, aged 27 years, was admitted with the diagnosis of rheumatic heart disease, mitral stenosis and insufficiency, auricular fibrillation, cardiac decompensation. The distribution of skin hyperesthesia, bone and muscle tenderness, is indicated in Figure 3, A. On January 12, 1934, left hemithyroidectomy was performed by Dr. Charles G. Mixter, under local novocain anesthesia. At the first examination 2 hours after operation muscle tenderness had disappeared and hyperalgesia and hyperesthesia of the chest had greatly lessened (Fig. 3, B). Two weeks later there was a gradual return of signs until the distribution of hyperalgesia was as indicated in Figure 3, C. On February 7, 1934, the right stellate ganglion was injected with 30 cubic centimeters of ½ per cent novocain by Dr. Jacob Fine. Five minutes later, the patient had developed enophthalmos, vasodilatation of the conjunctival vessels, ptosis of the lid and constriction of the pupil of the right eye. No changes were observed in the left eye. The right arm was warm and dry. Hyperalgesia of the right ribs and of the right sternomastoid, trapezius and the pectoralis major muscles had disappeared (Fig. 3, D). Twenty minutes after injection the eye signs had disappeared and slight muscle and bone hyperalgesia of the right thorax had reappeared. Three hours after injection all signs had returned to their former state.

## THE RELATION OF THE CARDIAC NERVES TO THE THYROID GLAND

As a result of careful dissections of macerated fetuses, designed to reveal the nerve supply of the thyroid and parathyroid glands, Braeucker (2) was able to state "dass die Herznerven in engster Beziehung zur Schilddruese stehen." His figures show that both the superior and middle cardiac nerves of the sympathetic, and the superior cardiac rami of the vagus nerves are in intimate relationship to the posterior capsule of the thyroid and contribute to the nerve supply of the

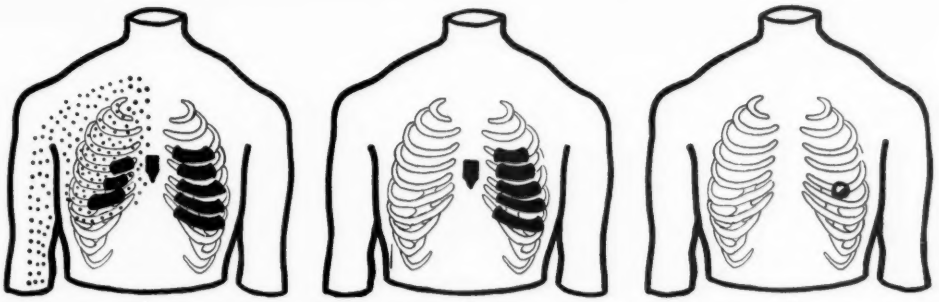



Fig. 2. Case 2. A, Before total thyroidectomy. B, During operation, after right hemithyroidectomy. C, During operation, after left hemithyroidectomy.

gland. To confirm Braeucker's results, and to investigate the constancy of these relationships in a larger series, dissections have been made in 10 fetuses and 6 adults.

The relation of the cardiac nerves to the posterior surface of the thyroid gland was demonstrated with the least possible distortion by a posterior approach. An incision having been made in the midline from the vertex to the fifth dorsal vertebra, the skin was retracted widely. The superficial muscles of the back were severed at their attachments to the vertebral spines and reflected laterally. The deep muscles of the neck and upper thorax were then completely removed, uncovering the posterior aspect of the vertebral column, and the medial portion of the upper thoracic ribs. The neural arches of the cervical and upper 5 thoracic vertebræ were removed with bone forceps. Beginning at the fifth thoracic vertebra the dorsal roots of the spinal nerves were exposed and traced peripherally to the ganglia, and the junction of the dorsal and ventral roots was identified. The rami communicantes then could be seen passing anteriorly to the sympathetic chain. The cervical and upper dorsal cord was split in the midline, and the two halves, with the dorsal and ventral roots, were reflected laterally. The exposed bodies of the vertebræ were removed piecemeal with fine rongeurs, and as the dissection proceeded, the rami communicantes were traced down to the sympathetic chain. The anterior vertebral muscles were dissected away, and the prevertebral fascia revealed, which forms the posterior limits of the compartment in which are located the pharynx and esophagus, the thyroid gland, and the great vessels and nerves of the neck. This fascia was carefully removed, disclosing medially the pharynx and esophagus, and laterally the 2 carotid sheaths, while in the angle between the inferior constrictor muscles of the pharynx and the carotid sheath were seen the lobes of the thyroid gland. Through this area the cardiac nerves could be traced.

*Results in the fetus.* Although the course of the cardiac nerves in the neck varied greatly in different dissections, two general types could be made out. The superior cardiac nerve usually followed one of two routes to the thorax. In 5 of the 20 dissections of the thyroid lobes the superior cardiac nerve followed the course of the sympathetic chain itself and lay entirely within the carotid sheath (Figs. 4 and 5, right side). In these specimens the nerve supply to the thyroid gland from the superior cervical ganglion arose by roots distinct from, and usually superior to, those of the superior cardiac nerve, though in several instances the superior cardiac nerve itself gave off long branches which left the carotid sheath and went medially to the thyroid gland.

In the 15 remaining dissections, the superior cardiac nerve was in close proximity to the thyroid gland. The roots of the nerve, usually 4 in number, left the carotid sheath immediately after arising from the superior

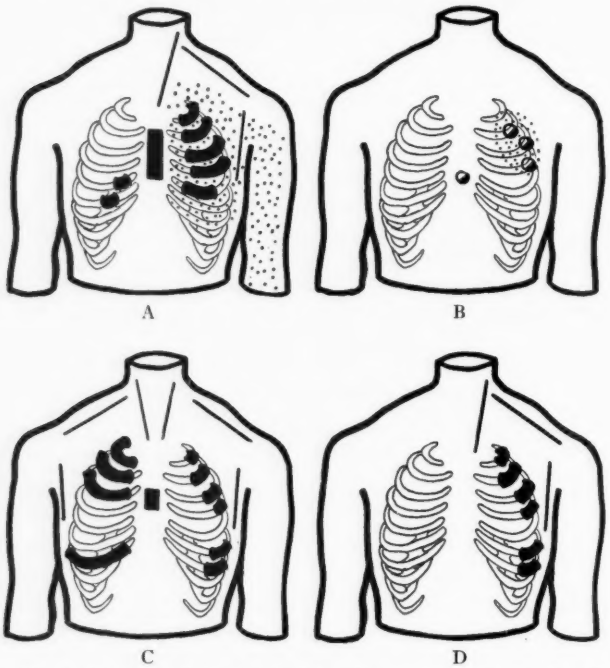



Fig. 3. Case 3. A, Before left hemithyroidectomy. B, 2 hours after left hemithyroidectomy. C, 2 weeks after left hemithyroidectomy; before stellate ganglion injection. D, 5 minutes after injection of stellate ganglion.

cervical ganglion and reached the posterior surface of the thyroid gland. Here they anastomosed freely with each other and with branches to the thyroid gland from the superior laryngeal nerve, the middle cervical ganglion of the sympathetic, the recurrent laryngeal nerve, and occasionally with the vagus or its branches, giving off fibers which penetrated the substance of the gland. Finally, near the inferior pole they united to form a single nerve which left the surface of the gland, and, giving branches to the middle cardiac nerve and the recurrent laryngeal nerve, entered the thorax.

In 15 of the 20 dissections the middle cardiac nerve remained within the carotid sheath and supplied no branches to either the thyroid gland or the inferior thyroid artery. In 5 dissections the middle cardiac nerve was in close proximity to the thyroid gland. In these cases, the nerve followed the course of the inferior thyroid artery near the thyroid gland, or crossed the posterior surface of the gland (Fig. 4, left). In 5 dissections the middle cardiac and superior cardiac united on the posterior surface of the gland and in 3 of these the superior cardiac ganglion was found at this junction, sending numerous branches into the substances of the gland. The combined nerve ran for some distance on the surface of the gland, giving off branches, and finally left the gland near the inferior pole to enter the thorax.

In no dissections was the inferior cardiac nerve in relation to the thyroid gland or to the inferior thyroid artery.

*Results in the adult.* The relations of the cardiac nerves to the thyroid gland in the adult were essentially as in the fetus. In 8 of the 12 dissections the roots forming the superior cardiac nerve descended medially and downward, ramifying over the posterior

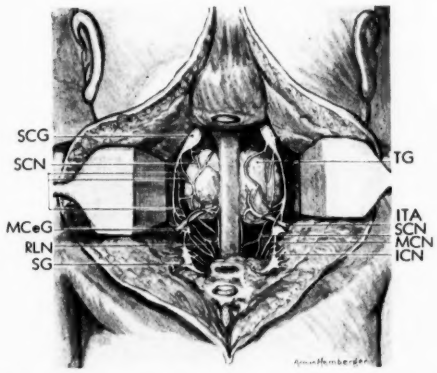



Fig. 4. Dissection of fetus. *SCG*, superior cervical ganglion; *SCN*, superior cardiac nerve; *MCeG*, middle cervical ganglion; *RLN*, recurrent laryngeal nerve; *SG*, stellate ganglion; *TG*, thyroid gland; *ITA*, inferior thyroid artery; *SCN*, superior—*MCN*, middle—and *ICN*, inferior cardiac nerves.

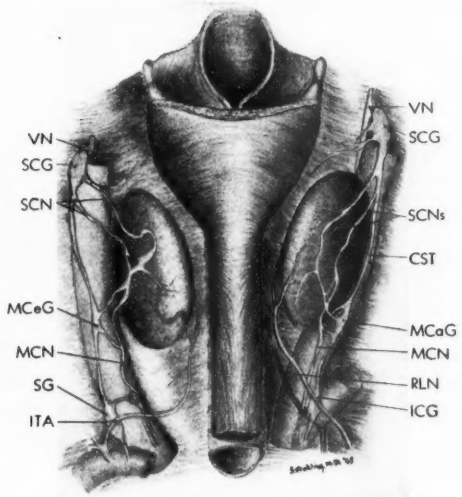



Fig. 5. Dissection of adult. *VN*, vagus nerve; *SCG*, superior cervical ganglion; *SCN*, superior cardiac nerve; *MCeG*, middle cervical ganglion; *MCN*, middle cardiac nerve; *SG*, stellate ganglion; *ITA*, inferior thyroid artery; *SCG*, superior cervical ganglion; *SCNs*, superior cardiac nerves; *CST*, cervical sympathetic trunk; *MCaG*, middle cardiac ganglion; *RLN*, recurrent laryngeal nerve; *ICG*, inferior cervical ganglion.

surface of the thyroid gland and giving numerous branches to its substance. These branches finally united to form the nerve itself, which, after a short course on the posterior surface of the gland, left it to re-enter the carotid sheath and thus reach the thorax. In the 4 other dissections, as in some fetuses, the superior cardiac nerve ran its entire course within the carotid sheath, and the sympathetic nerves to the thyroid gland arose by separate roots from the superior cervical ganglion, or by one or two long branches from the superior cardiac nerve itself as it coursed downward in the carotid sheath.

In only 1 dissection was the middle cardiac nerve close to the thyroid gland, and in no case was there any association between the inferior cardiac nerve and the gland.

## EVALUATION OF STUDY

In a previous communication from this laboratory, the early relief of pain induced in patients with angina pectoris and congestive heart failure by total ablation of the thyroid gland was ascribed to interference by the operative procedure with afferent nerves from the heart. In the present report this thesis is afforded further confirmation by the demonstration of the definite relationship of certain cardiac nerves to the thyroid gland, and by clinical observations in which muscle and bone tenderness, and skin hyperesthesia have disappeared at the very moment of surgical procedures which would damage the nerves involved.

Processes involving nervous activity are immediately disrupted by damage to the nerves involved, and this immediate cessation of activity has become an essential criterion for demonstration of nervous participation. Hormonal medication is known to be slower in effect, and hours and even days elapse before changes take place. In the case of thyroidectomy it has been clearly shown that many hours are required before the concentration of circulating thyroxin is measurably diminished. Although in previous reports (11) early relief of pain was noted as soon as 2 hours after operation, much before hormonal effects might be expected, the present observations show that relief from pain occurs abruptly during the course of operation, the moment the gland is lifted from its bed, an artery cut, or during some other procedure

which might be expected to damage the posterior thyroid nerve network. Such definite implication of nervous activity is afforded confirmation by the report of another instance in which unilateral removal of one thyroid lobe was immediately followed by relief only on the same side.

The intimate association of the thyroid gland and certain cardiac nerves was first revealed incidental to study of the innervation of the thyroid gland. Careful dissections by Braeucker (1, 2, 3) in man, confirmed later in the higher apes by Riegle (10), showed that the sympathetic innervation of the thyroid is mainly from the superior cardiac nerve, arising from that nerve as it or its roots lie against the posterior surface of the thyroid gland. Braeucker also demonstrated a less frequent association of the middle cardiac nerve with the posterior surface of the thyroid, and found that at times the superior cardiac ganglion was also applied to the posterior surface of the gland near its inferior pole, and that from this ganglion numerous fibers arise which pass to the gland. The detailed drawings of Braeucker's dissections indicate how very difficult it would be entirely to remove the thyroid gland without cutting, crushing, or tearing away a large proportion of the nervous network lying on its posterior surface, especially when at every point this meshwork is anchored to the gland by penetrating twigs.

The observations reported here greatly increase the number of dissections on record, and extend them to adults. In all, 16 dissections were made, thus the relationships of the cardiac nerves to 32 thyroid lobes were investigated. Our observations entirely confirm the work of Braeucker and Riegle, and emphasize the extremely intimate association of the thyroid gland and the superior cardiac nerve, and to a lesser extent, the middle cardiac nerve. In approximately 30 per cent of the dissections the superior cardiac nerve was within the carotid sheath during its entire course and so was not close to the gland; in more than 70 per cent of the dissections, however, the relation described by Braeucker was found. This variability is of much the same order as the variability of appearance of the early relief of pain following total removal of the thyroid gland, and is probably one of the factors accounting for the failure to obtain immediate postoperative relief in all patients. The other factor is probably the variation in the sensory outflow of the heart, which has been shown by White to involve the thoracic fibers of the sympathetic as far caudal as the fourth or sixth ganglion.

The presence in the superior cardiac nerve of sensory fibers arising from the heart was at one time denied by the majority of investigators, including Langley, Ranson, and Ionescu. White routes the main afferent outflow from the heart through the first 5 thoracic nerves, and the middle and inferior cardiac nerves of the sympathetic, and states that the superior cardiac nerves are "supposed" to be purely motor. Operations such as that of Coffey and Brown, however, did result in relief, though usually temporary, in a certain number of cases, and since here the main effect was to destroy the central connections of the superior cardiac nerve, it is more than probable that this nerve does carry afferent fibers from the heart. The recent work of Heinbecker leaves little doubt of the presence of afferent fibers in the superior cardiac nerve, and Leriche and Fontaine agree that the superior cardiac nerve contains afferent fibers.

In addition to the superior cardiac nerve, it must be remembered that the middle cardiac nerve was associated with the thyroid gland in about 20 per cent of the cases and that the cardiac rami of the vagi may not infrequently be involved.

## SUMMARY

1. Observations on the immediate relief of hyperesthesia and hyperalgesia of the chest during total thyroidectomy are described in 3 patients.

a. In 1 patient immediate relief of muscle and periosteal hyperalgesia of the chest wall occurred after the severance of the inferior thyroid vessels.

b. In the second patient immediate unilateral relief occurred after one lobe of the thyroid was shelled out of its bed. Immediate relief of hyperalgesia occurred on the left side

of the chest after the second lobe of the thyroid gland was removed.

c. In the third patient the results of hemithyroidectomy and block of the stellate ganglion in hyperalgesia of the chest were compared. In both cases there was loss of muscle and periosteal tenderness of the chest.

2. Anatomical dissections of 10 fetuses and 6 adults of varying ages demonstrate an intimate relation of the cardiac nerves to the thyroid gland.

a. In 70 per cent of the dissections of the thyroid lobes the superior cardiac nerve was closely applied to the posterior surface of the lobes of the thyroid.

b. In 20 per cent of the dissections of the thyroid lobe the middle cardiac nerves were in apposition with the posterior surface of the thyroid lobes or the inferior thyroid vessels.

## CONCLUSION

The immediate relief of pain in patients with angina pectoris and congestive failure observed after total thyroidectomy is due to injury to the superior and middle cardiac nerves and nerve plexuses on the posterior surface of the thyroid gland and its vessels.

The authors are grateful to Professor Wislocki of the Department of Anatomy, Harvard Medical School; Professor Allen of the Department of Anatomy, Yale School of Medicine; and Dr. Schlesinger of the Department of Pathology, Beth Israel Hospital, for their kindness in supplying specimens for dissection; and to Dr. H. L. Blumgart, under whose direction these investigations were carried out, for his constant assistance.

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# PERSISTENCE OF DUODENAL ULCERS AFTER SUTURE OF AN ACUTE PERFORATION

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PERFORATED duodenal ulcer in the male constitutes one of the most frequent causes for an acute abdominal condition. For this reason it seems of considerable interest and importance to investigate different problems presented by this disease.

Many contributions have appeared in the literature during the last 30 years pertaining to symptoms and treatment of these acute perforations. Questions of operative technique and mortality statistics have been discussed in detail. With the general trend toward earlier diagnosis and immediate operation contributed by refinements in diagnostic procedures (roentgen-ray films, blood counts, etc.), the mortality has been gradually reduced, so that it is not more than about 10 per cent in any large series of cases.

Considering the vast amount of writing that has accumulated dealing with the operative phases of this subject, it is surprising how scarce are data concerning the end-results after patients have recovered from the emergency operation for perforated duodenal ulcers.

Simple closure, usually by a two layer purse-string suture, is the most frequently employed operative procedure in dealing with acute duodenal perforation. Gastro-enterostomy, as an additional procedure, is rarely employed except in those rare instances in which a pyloric obstruction is caused by the infolding stitches in the presence of a large perforation.

The dramatic change in the entire clinical picture from an acute abdominal emergency to an uneventful postoperative course is very satisfactory to the patient and surgeon. The former thinks that following his splendid recovery, he will be free from further trouble. In this erroneous impression he is often supported by his physician who tells him that the best and safest way to cure an ulcer is an acute perforation, a so called "blow out."

I do not know on what basis the impression that an acute perforation cures the ulcer is so widespread. Only recently I heard that a surgeon told a colleague, who had just recovered from an acutely perforated duodenal ulcer, that the acute perforation was a blessing, as he was now definitely and permanently guarded from further trouble. This patient had symptoms again within a few months of the operation in spite of the good prognosis, given him by the senior surgeon.

The true picture of the life-story of a perforated ulcer after suture is usually entirely different from the optimistic view expressed by the surgeon just quoted. The acute perforation usually takes place in the center of the ulcer. Although the perforation is only pinpoint in size, the ulcer area varies at times from that of a 10 cent piece to that of a quarter of a dollar. In the majority of cases the sutures which close the perforation have to be placed in the area of surrounding acute inflammation. It is perfectly clear that the simple suture of a small perforation is not apt to cure the large ulcerated lesion.

There is another very good reason why an acute perforation of an anterior wall ulcer is not prone to effect a permanent cure, even if the ulcer is of small size, namely, the frequency of so called kissing ulcers. In about 50 per cent of duodenal ulcers, 2 or more ulcers are found in the specimens examined after partial gastrectomy. The posterior wall, with penetration of the ulcer into the pancreas, is one of the most frequent locations for duodenal ulcers. Only those who, in the course of a partial gastrectomy, free the duodenum from the pancreas are aware of the frequency of these posterior wall lesions. Those who perform pyloroplasties or gastro-enterostomies are only too apt to overlook these lesions.

From the Surgical Service Mount Sinai Hospital.

In a paper published in 1928 (3), I have called attention to the fact that 39 per cent of the patients have persistence of ulcers following a suture of an acute perforation. I use the word "persistence" advisedly. All the other authors dealing with this subject use the term "recurrences." In order to recur, a lesion must have disappeared completely, at least temporarily. However, these lesions are present before the perforation, and persist after the suture of the perforation. They persist until the lesion is removed with the ulcer-bearing area (distal half of the stomach) by partial gastrectomy.

It appears from a paper recently presented by Sallick before the Surgical Section of the New York Academy of Medicine that my figure of 39 per cent was rather conservative. He noticed 71 per cent of persistent symptoms among those patients whom he could re-examine personally, whereas those whom he could reach by questionnaire only, showed a much smaller figure, namely, 46 per cent. The divergence in these follow-up results is very interesting. In publishing the very high figure of 34 per cent of gastrojejunal ulcers following gastro-enterostomy for duodenal ulcers, I pointed out that these data (2) were obtained by a careful personal re-examination of the patients. Others who presented a smaller number of recurrences had arrived at their results on the basis of questionnaires. Sallick's figures (71 per cent and 46 per cent) prove the importance of a personal examination of the patient. Our figure of 39 per cent of persistent symptoms after suture of a perforated duodenal ulcer was arrived at by personal examinations only.

The frequency of acute perforation of anterior duodenal ulcers makes a more radical approach to this lesion imperative. About 10 years ago a father and son were admitted to the surgical service of Mount Sinai Hospital within a few months of each other, the father with an acute perforation, the son with profuse hemorrhage from a duodenal ulcer; both had been discharged a few months before from the medical service. Both were subjected to a partial gastrectomy;—the father a few months after the suture of the perforation, the son a short while after he had recovered from the severe hemorrhage which necessitated 5 preoperative blood transfusions. If a duodenal ulcer does not respond readily to medical treatment, or if symptoms recur at short intervals, it seems much safer to subject the patient to a partial gastrectomy rather than have him face the serious complications which are the result of perforation of an ulcer or hemorrhage.

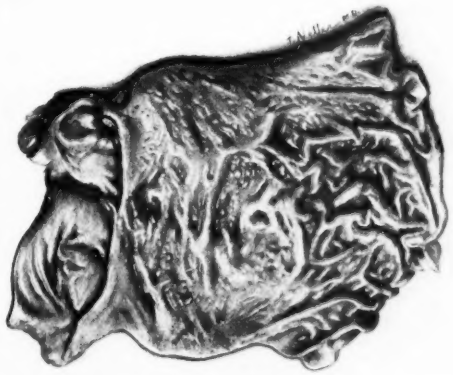

Fig. 1. Case 1. Ulcer at the superior border of the duodenum.

The diagnosis of a persistent duodenal ulcer must be made on purely clinical grounds, possibly aided by a Rehfuss test-meal. Roentgen-ray studies are of little value, unless they show retention. A deformity of the cap always persists after a previous operative interference, even in the absence of an active lesion.

I am presenting records of 4 patients upon whom I recently operated for persistent duodenal ulceration after an acute perforation. The detailed case reports and the reproductions of the specimens obtained by partial gastrectomy demonstrate very well my contention that in spite of previous perforation a severe ulcerative lesion in the duodenum may persist.

The patients were re-operated upon within a year after the suture of the perforation. The fact that these patients were willing to submit to another operation a few months after the primary procedure is sufficient evidence that the persistent symptoms following operation were severe.

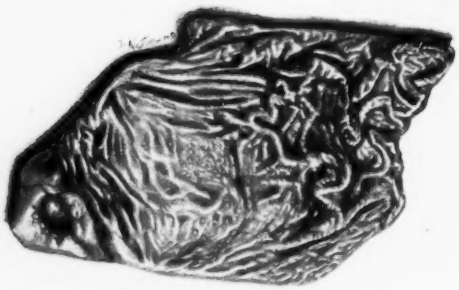

Fig. 2. Case 2. Duodenal ulcer on the posterior wall penetrating into the head of the pancreas.

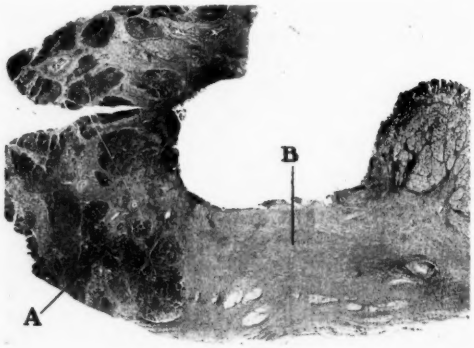


Fig. 3. Case 2. Microscopic section showing pancreatic tissue, *A*, and the base of the ulcer, *B*.

CASE 1. S. I., male, 53 years of age, was admitted to Mount Sinai Hospital on February 1, 1933. He had had an indefinite history of epigastric pain for 4 days before his admission. The epigastric distress became much worse 5 hours before his admission to the hospital.

Physical examination showed marked tenderness on the right side of the abdomen. There was no obliteration of the liver dullness. Temperature was 101 degrees; white blood count, 11,600 with 81 per cent polymorphonuclears. Flat plate of the abdomen failed to reveal the presence of free air.

The differential diagnosis lay between acute cholecystitis and perforating duodenal ulcer. During the next few days the process subsided. A gall-bladder series of roentgenograms failed to visualize the gall bladder.

On the eighth day after admission, an exploratory laparotomy was performed under spinal anesthesia, supplemented by gas, oxygen, and ether. A right rectus incision was made. The gall bladder was slightly distended, but did not contain any stones. There were adhesions of the gall-bladder fundus to the duodenum. When these adhesions were freed, it was evident that the gall bladder had covered a perforated duodenal ulcer. The perforation was very small, but the surrounding parts of the duodenum were markedly inflamed. In view of the marked inflammation of the duodenum and of the fact that the patient did not react well to the anesthesia, it was decided to sew over the ulcer and not subject the patient to a gastric resection at this time. The perforation was sewed up by using a pursestring suture for the first layer and interrupted catgut sutures for the second layer. The abdomen was closed in layers without drainage.

The patient made an uneventful postoperative recovery and was discharged from the hospital on February 26, 1933.

He was re-admitted January 26, 1934. He had been free from symptoms for about 8 months. He had been seen in our return clinic repeatedly and as his symptoms, instead of subsiding, grew worse, he was advised to have a partial gastrectomy performed for persistent duodenal ulcer.

This operation was performed on January 29, 1934, under gas, oxygen, ether anesthesia. A midline incision was made between the ensiform process and the umbilicus. There were a few adhesions of the liver to the previous right rectus incision and there were considerable adhesions between the stomach and the liver. These adhesions were divided. The stomach and duodenum were then brought forward. The ulcer could be felt about a half inch below the pyloric ring. It was situated at the superior border of the duodenum. A typical partial gastrectomy (Billroth II type) was performed and the abdomen was closed in layers (Fig. 1).

The patient made an uneventful recovery and left the hospital on February 17, 1934.

CASE 2. J. I., male, aged 47 years, was admitted to Mount Sinai Hospital on May 28, 1933. This patient had been suffering for the past few months from epigastric pain. One year before admission he had a gastro-intestinal series of roentgenograms taken in the Out-Patient Department of the hospital; this revealed the presence of a peptic ulcer. He was then given ambulatory treatment. Six hours before admission he was suddenly seized with severe generalized lower abdominal pain and fell to the floor.

On admission he had boardlike rigidity with obliteration of liver dullness and tenderness over the entire abdomen. He was operated upon immediately and a perforated peptic ulcer was found near the pylorus. The perforation was sewed over and the abdomen was closed without drainage.

The patient made an uneventful recovery and left the hospital on June 13, 1933.

He felt well for about 6 months, when his old symptoms of heartburn and epigastric pain after intake of food began to recur. He is supposed to have had a few diarrheal stools. Gastric analysis showed 63 free hydrochloric acid and 80 total acid-

ity. He was re-admitted on March 21, 1934. Partial gastrectomy for penetrating duodenal ulcer was performed under spinal anesthesia (150 mg. neocaine), which was ineffectual and had to be supplemented by gas, oxygen, ether. A midline incision was made between the ensiform process and the umbilicus. Extensive adhesions between the liver, gall bladder, and stomach were divided. The gall bladder, which was very thin, was gently pushed away from the operative field. A large ulcer was felt in the first part of the duodenum densely adherent to the pancreas and representing a large mass about the size of a plum. In view of the fact that this man had a previous operation for perforated ulcer and that in the absence of retention no benefit could be derived from the simple procedure of a gastro-enterostomy, a partial gastrectomy (Billroth II type) was performed. After ligation of the four cardinal vessels and the gastrocolic ligament, and after division of the stomach just above the re-entrant angle, the distal part of the stomach was pushed over to the right, thus exposing the ulcer area. The ulcer was situated on the posterior wall of the duodenum with penetration into the pancreas. It required a deep dissection in the region of the head of the pancreas to get beyond this ulcer in order to make possible an adequate suture of the duodenum. The abdominal wall was closed in layers, after a small tube had been introduced into the region of the head of the pancreas.

The patient made an uneventful recovery and left the hospital on April 15, 1934.

The specimen (Fig. 2) shows a deep penetrating ulcer on the posterior wall of the stomach. A piece of pancreas measuring 2½ by 1½ by 3 centimeters presents the base of the ulcer. The microscopic section (Fig. 3) shows very well the base of the ulcer and the resected portion of the head of the pancreas.

CASE 3. B. D., a male, aged 58 years, was admitted to the hospital on September 30, 1935, and died on October 11, 1935. This patient was referred to the hospital by Dr. B. B. Crohn, on account of persistent ulcer symptoms following a suture of a perforation of an acute duodenal ulcer done previously at another hospital. After weighing the evidence for a few days, operation was performed on October 4, 1935, under spinal anesthesia (neocaine 0.15) which had to be supplemented after three-quarters of an hour by general anesthesia. Partial gastrectomy for duodenal ulcer was performed. The old scar was excised and the abdomen entered easily as there was a ventral hernia. Some adhesions between the omentum and the abdominal wall were separated and cut. The ulcer was palpable on the anterior wall near the upper angle of the duodenum. The gall bladder was densely adherent to it and was separated from this lesion by sharp dissection. This dissection was carried to the foramen of Winslow, thus liberating the gall bladder from the duodenum. Before proceeding further with the dissection of the pancreas, the four cardinal arteries were divided and the stomach was cut through above the re-

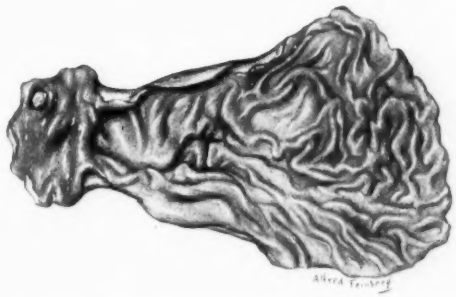

Fig. 4. Case 3. Ulcer on the anterior wall of the duodenum.

entrant angle in typical fashion. After the division of the stomach, the posterior wall of the duodenum was exposed, and adhesions between the duodenum and pancreas were divided, thus liberating the duodenum sufficiently for a safe suture. The duodenum was then cut through below the ulcer and the duodenal opening was closed in three layers, the pancreatic capsule being used for the third layer. An end-to-side gastro-enterostomy (Billroth II type) was performed. A ventral hernioplasty was then performed.

The specimen (Fig. 4) showed very marked gastritis in the distal half of the stomach and a punched out ulcer on the anterior superior border of the duodenum, just beyond the pylorus.

The postoperative course of this patient was perfectly smooth during the first 48 hours. However, on the third day after operation, marked signs of pneumonia developed, to which he succumbed on October 11, 1935.

Postmortem examination showed that the abdominal cavity was free from any infection and that all the suture lines were intact. The patient died from a lobar pneumonia of the right upper lobe and a patchy bronchopneumonia of the right lower lobe.

CASE 4. J. S., male, aged 45 years, was admitted to the hospital on December 6, 1935, discharged on March 15, 1936.

This patient had been operated on in May, 1935, at this hospital for an acute perforation of a duodenal ulcer; simple suture of the perforation had been performed and the abdomen had been closed without drainage. The patient was re-admitted to the medical service in September, 1935, for epigastric distress. The roentgenograms showed an irregularity in the duodenum. The acid figures were 80 free and 110 total; there was no gastric residue. The patient was treated medically and discharged improved. Upon his present (the patient's third) admission to the hospital he stated that his symptoms recurred soon after the discharge from the medical service of the hospital and he now vomited frequently. There was no blood in the stools, no blood in the

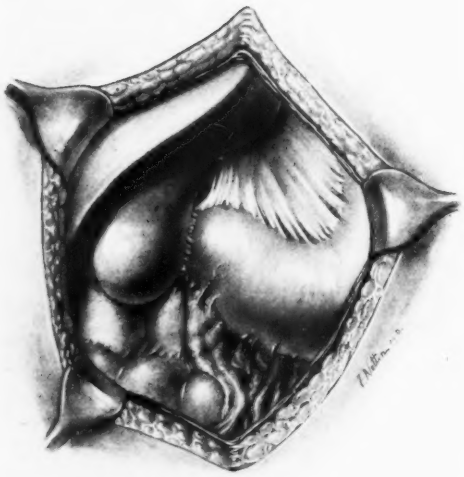

Fig. 5. Case 4. The gall bladder covering the huge duodenal ulcer.

Fig. 6. Large, circular ulcerative defect between pylorus and duodenum after the gall bladder had been liberated.

vomitus. In view of the persistent severe symptoms it was deemed advisable to perform a partial gastrectomy upon this patient.

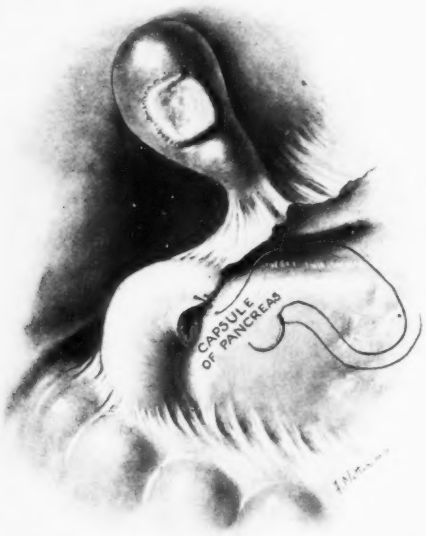


Fig. 7. Case 4. Closure of the duodenum.

Operation was done on December 11, 1935, and consisted in partial gastrectomy for a large penetrating duodenal ulcer. Under pantocaine anesthesia, which was very efficient, the old scar was excised and the abdominal cavity was entered easily. There were a number of adhesions of the omentum to the parietal peritoneum which were divided. A large mass presented itself which, on palpation, felt somewhat like a malignancy. On further investigation it was found that it was an acute inflammatory process.

There was a huge ulcer present which took up the whole circumference of the pyloric region (Fig. 5). The gall bladder was plastered to this mass, and formed the anterior portion of the ulcer. Before separating the gall bladder from the ulcer and thus opening into the lumen of the stomach, it was deemed advisable to start from above and divide the cardiac and the left gastro-epiploic arteries and the gastric colic ligament. After the stomach had been freed sufficiently, the pancreaticoduodenal artery was divided. The colon was pushed away and the pyloric artery was divided and cut. A large stomach clamp was then applied above the reentrant angle. The individual vessels in the stomach wall were cut and the stomach was divided. We were thus able to swing the distal half of the stomach toward the right and free the posterior adhesions between this large ulcer and the pancreas. The gall bladder was now freed from the ulcer and pushed back.

After the gall bladder had been freed, a large defect in the ulcer, about one-half inch in diameter,

which had been covered by the gall bladder, presented itself. The mucous membrane of the pyloric region had been divided in two parts, the upper part belonging to the stomach and the lower part to the duodenum. Between these two parts, there was a defect which represented a very large ulcer which surrounded the whole circumference of the upper part of the duodenum in the pyloric region (Fig. 6). The duodenum was now cut across and the opening in the duodenum was closed, not by using the duodenal mucous membrane as we usually do, but by inverting immediately and suturing the anterior duodenal wall right to the capsule of the pancreas (Fig. 7). A second and third layer re-enforced this suture line. The anastomosis between the stomach and the jejunum was performed in typical fashion, closing the upper third of the stomach and anastomosing the lower two-thirds with the jejunum. Luken's catgut was used. A tube was put into the subhepatic space and a ventral hernioplasty was performed. For this latter procedure it was necessary to give the patient a general anesthetic.

Specimen showed chronic peptic duodenal ulcer.

The postoperative course was very prolonged, requiring hospitalization for 3 months. The patient developed an abdominal wall infection which was attributed, at first, to the marked tension which had to be exercised in repairing the ventral hernia. There was never any leak from the duodenum or stomach. There was no vomiting during the entire postoperative course and the bowels moved normally. The patient developed a large mass in the right side which drained a moderate amount of pus. Lipiodol injection into the sinus tract on January 23 showed that the tract communicated with the jejunum. There evidently was a small pinpoint lumen in the duodenum which kept up the suppuration described. Under expectant treatment and daily dressings, the temperature, which ranged between 102 and 103 degrees for a number of weeks, gradually came down to normal. There was no elevation of temperature during the last 2 weeks of the patient's stay in the hospital. The sinus tract healed up completely, the mass described above, though still present, was smaller. Patient discharged, at own request, to Out-Patient Department on March 15, 1936.

Follow-up, May 12: Patient is perfectly well. The inflammatory mass has disappeared completely. He has gained 38 pounds since the operation.

Before closing I would like to sound a note of warning against any secondary palliative operation in dealing with these ulcers. Primary gastro-enterostomy at the time of the suture of the acute perforation has been abandoned on account of the frequency of gastrojejunal ulcers following the performance of a gastro-enterostomy in the presence of an acute lesion (Enderlen, 51 per cent). Neither gastro-enterostomy nor pyloroplasty will cure these patients. Partial gastrectomy is the only logical procedure for the cure of persistent duodenal ulcers after a previous perforation.

## CONCLUSIONS

Many patients have persistent ulcer symptoms after suture of an acute perforation. These symptoms are due to the fact that the anterior wall ulcer persists in spite of the previous perforation or that in addition to the anterior ulcer which perforated acutely and was sewn over, a posterior wall ulcer existed which, of course, was not affected by the surgical procedure. The diagnosis must be made on clinical grounds, as the roentgen-ray examination will show distorted duodenal bulbs in all cases in which patients were subjected to a previous operation on the duodenum. If severe ulcer symptoms persist after the suture of a perforation has been done, patients should be reoperated upon and a partial gastrectomy should be carried out.

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# A STUDY OF PLACENTA ACCRETA

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PLACENTA accreta is the abnormal adherence, either in whole or in part, of the afterbirth to the underlying uterine wall. Its pathological background is a complete or partial absence of the decidua basalis and in particular of its deep or spongy layer which lies upon the myometrium and results from the lateral elongation and compression of the mucosal glands. As described by Langhans in 1875, the normal separation of the placenta in the third stage of labor is caused by the cleavage of this spongy layer (Fig. 1). Complete or partial absence of the decidual coat forces the chorionic villi to attach themselves directly to the myometrium and even in some instances to penetrate deeply into the uterine wall, giving rise to the condition known as placenta increta, or, when it actually perforates the uterus, as placenta percreta.

We present 20 cases of this condition, all verified by histological examination. Pathological examination of the first 8 cases was made at the Boston City Hospital. The specimen from Case 9 was examined at the Pathological Laboratory of the Harvard Medical School. Sections from these sources, when available, were reviewed, and the remaining specimens from the pathological laboratory of the Boston Lying-in Hospital were studied by one of us (A.T.H.). Two were incidental early examples discovered in pregnant uteri removed for other causes. Eighteen, however, were clinical cases of placenta accreta. In each of these instances retention of the afterbirth had led to an intra-uterine exploration. In 6 cases the placentas were completely adherent and in 12 cases, although partial planes of cleavage were found, there still remained considerable portions firmly attached to the myometrium. Placenta accreta is not to be confused with simple retention of the afterbirth either through failure of the normal mechanism of separation in a healthy uterus or through its imprisonment behind an hour glass contraction.

From the Departments of Obstetrics and Pathology, Harvard Medical School, and the Boston Lying-in Hospital. Read in part before the American Gynecological Society, May 27, 1936.

The period embraced in this study extends from January 1, 1925, to January 1, 1936, and covers 11 years. During this time there were 35,203 deliveries in the house and out patient departments of the Boston Lying-in Hospital. Clinical placenta accreta, therefore, occurred once in every 1,956 deliveries. Three of our cases were derived from outside sources, having been referred to the hospital by family physicians. Kraul states that there were 3 cases in 60,000 births in the Vienna clinic, an incidence of 1 in 20,000, while Blagodarow believes it to be 1 in 16,000. Brosin, in his discussion of the paper by Leopold and Leisse gives its frequency as 1 in 10,000 and Polak and Phelan, 1 in 6,000. It is our opinion that all cases of partial placenta accreta do not appear in the literature, since the deaths from hemorrhage or sepsis that ensue have been charged to manual extraction of the placenta. This belief is given some weight by the high death rate, 10.75 per cent, that has been attributed by Peckham to manual removal of the afterbirth. Moreover, of the cases reported in the literature those of complete adherence outnumber those of partial accreta 9 to 7, while our experience shows that the ratio is 1 to 2.

## BOSTON LYING-IN HOSPITAL CASES

CASE 1. M.D., No. 34,595, aged 33 years, septipara, full term. All confinements had been normal except the last which occurred 3 years ago. This delivery, although spontaneous at 7 months, was followed by a postpartum hemorrhage. The placenta was expressed, however, and manual extraction was not necessary. Patient was delivered at home, December 19, 1925, normally, by the family physician. The placenta failed to separate and the patient was sent to the hospital. The pulse rate was 140; blood pressure was 60 systolic on admission. She was cold and in shock and there was free bleeding

Fig. 1. A normal fullterm placenta *in situ*. Phosphotungstic acid hematoxylin stain. ×23.

The fetal trophoblastic layer is somewhat thin and degenerated. A single fibrin stria is now present (resulting from the fusion of Rohr's and Nitabuch's striæ). The compact and spongy decidua is still observed but each is less prominent than in earlier stages of pregnancy. The presence of a villus within the vascular sinusoid is a normal phenomenon and hence is not one of the factors responsible for the adherence of the placenta in placenta accreta.

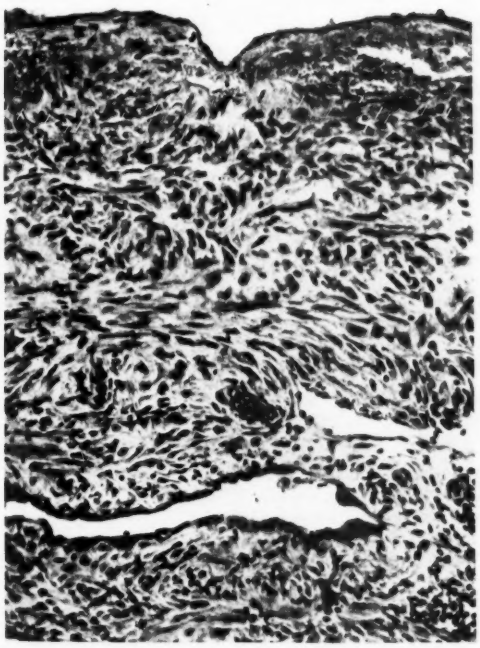

Fig. 2. Normal decidua vera from Case 6, a full term complete placenta accreta. Hematoxylin and eosin stain. ×157. (Same case as shown in Figs. 4 and 5.) Compare with normal full term decidua vera at same magnification as seen in Figure 3.

from the uterus. Patient was given 600 cubic centimeters of citrated blood and 1000 cubic centimeters of salt solution. Following this an examination under anesthesia showed the placenta to be densely adherent to the corpus of the uterus on its posterior surface. Supravaginal hysterectomy without drainage was done. Convalescence was febrile from the third to the tenth day. A mass developed in the right vaginal vault and there was a profuse vaginal discharge. Both gradually subsided and the patient was discharged with her infant on the thirty-first day. Birth weight of infant was 8 pounds, 5 ounces.

Diagnosis: complete placenta accreta.

*Pathological report.* B.C.H.Path. No. S-25-2855. The specimen consisted of a postpartum uterus with an entire placenta firmly attached to the posterior aspect of the corpus. The decidua vera was essentially aglandular except for rare glands extending into the muscle. There were fibrosis and moderate chronic inflammation of decidua vera although there were a few typical decidual cells present in this layer. Most of them, however, resembled recent fibroblasts. The decidua basalis was deficient in both compact and spongy elements, often the villi were directly embedded in muscle and were occasionally seen in the underlying myometrial sinusoids. The irregular, hyalinized layer of trophoblast, often called Nitabuch's fibrin stria, was intimately fused with the muscle of the uterus. The vascularity of the placental site was not unusual. No fibrosis or chronic inflammation of placental site was observed.

This case is interesting historically, since it appears to have been the first to receive a transfusion.

CASE 2. M.C., No. 37,093, aged 26 years, secundipara, full term. First infant was delivered normally, 1 year ago; no hemorrhage. Patient was delivered at 7:05 a. m. February 23, 1927, normally, in the out patient department. The placenta did not separate and there was a fair amount of bleeding. She was sent to the hospital in an ambulance. On admission to the hospital, patient was pale; pulse, 148; blood pressure, 70 systolic. She was examined under anesthesia. The placenta was found on the left anterolateral wall of the corpus. The plane of cleavage was found, but placenta was adherent in the upper portion. In pulling down the placenta, the uterus was completely inverted. The remaining portion of the placenta was removed with gauze and curette. The uterus was replaced and packed. She was given a transfusion of 350 cubic centimeters of

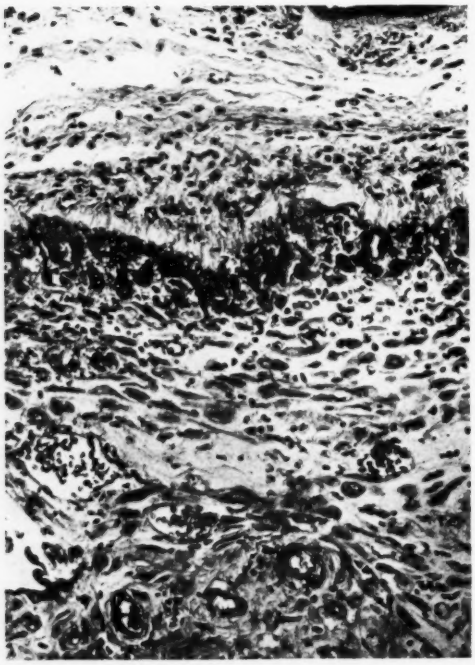

Fig. 3. Decidua vera compacta with adherent chorion levæ from case of full term pregnancy. (Hysterectomy for prolonged ruptured membranes without labor.) Phosphotungstic acid hematoxylin stain. ×157. Compare this with scarred decidua vera associated with case of complete placenta accreta seen in Figure 2.

citrated blood. The pack was removed the next day. Convalescence was mildly febrile to the nineteenth day. Patient was discharged with infant on the twenty-fourth day. Birth weight of infant was 6 pounds, 3 ounces.

Diagnosis: partial placenta accreta with inversion of the uterus.

*Pathological report.* B.C.H.Path. No. S-27-430. Specimen consisted of the placenta which measured 15 by 15 by 2 centimeters and was more friable and somewhat drier than usual. The one significant microscopic section showed an intimate fusion of myometrium with the normal, somewhat hyalinized trophoblastic layer of the placenta. No decidual cells were seen. The only placental septum encountered showed its base to be partly composed of smooth muscle. No fibrosis or inflammation was present. No decidua vera was obtainable.

Case 3. A.F., No. 37,269, aged 34 years, tripara, 24 weeks pregnant. First delivery was by forceps; second delivery was complicated by eclampsia. Patient entered the hospital March 17, 1927, with blood pressure of 198/130 and headache. The urine

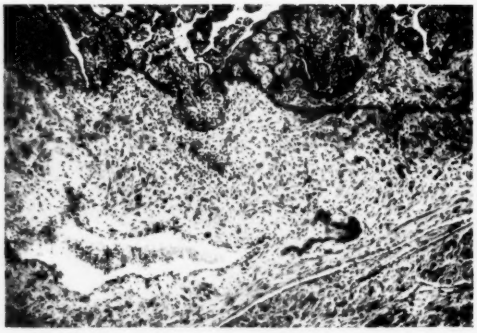

Fig. 4. Case 6. A full term complete placenta accreta. Hematoxylin and eosin stain. (From same specimen as Figs. 2 and 5.) ×37.

Villi and irregular, hyalinized trophoblastic layer fused with myometrium. Decidua and Nitabuch's fibrin stria absent. There is slight fibrosis and chronic inflammation of the myometrium just beneath the placenta.

boiled almost solid. Cesarean section was done the day patient entered the hospital. Multiple fibroids were found. The placenta was removed with difficulty, particularly where it overlay a submucous fibroid. Supravaginal hysterectomy was done and drain was placed through the cervix to the vagina. Convalescence was very stormy; the wound burst on the eighth day after operation and was resutured. She had fever to the thirty-fifth day. She was discharged on the sixty-fifth day. The infant was nonviable and died at birth.

Diagnosis: fibroids of the uterus, toxemia, bronchopneumonia, partial placenta accreta.

*Pathological report.* B.C.H.Path. No. S-27-653. The specimen consisted of two pieces of tissue 2 by 1 by 0.2 centimeters and 3 by 2 by 0.5 centimeters with soft red margin at one side. One surface was red, rough, and firm. The placenta was intimately connected to the muscle wall with little evidence of endometrium. This apparently is an example of placenta accreta.

Case 4. M.F., No. 37,370, aged 32 years, septipara, full term. Three children had been delivered normally at home. The last four pregnancies had terminated in miscarriages at 4 months. Patient had been delivered normally in the out patient department at 6:00 a.m. April 3, 1927. The membranes had ruptured 2½ days before. The placenta did not separate. There was very free bleeding. Patient was sent to the hospital by ambulance. She was cold and pale on admission; pulse was 140; blood pressure, 96 systolic. She was given a transfusion of 500 cubic centimeters of citrated blood followed by 500 cubic centimeters of salt solution. Examination was done with patient under anesthesia. The placenta was found in the left corpus and cornu. It separated readily except for the portion adherent to the left cornu which was freed with difficulty. Moderate

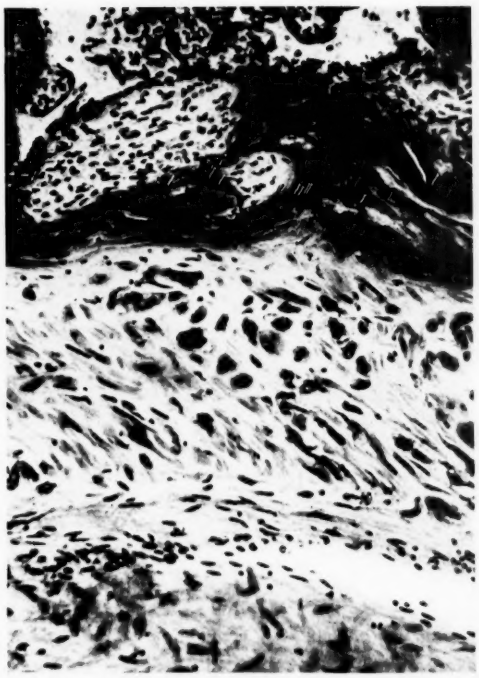

Fig. 5. Case 6. A full term complete placenta accreta. Hematoxylin and eosin stain. (Same specimen as shown in Figs. 2 and 4.) ×157.

Chorionic villi enmeshed in Rohr's fibrin stria fused with myometrium which is the seat of slight fibrosis. The isolated cells in the fibromuscular tissue beneath the placenta are of trophoblastic origin and not decidual.

bleeding ensued. Convalescence was afebrile. She was discharged with infant on the fourteenth day. Birth weight of infant was 8 pounds, 14 ounces.

Diagnosis: partial placenta accreta.

*Pathological report.* B.C.H.Path. No. S-27-779. A piece of placenta 5.5 by 4.0 by 2.0 centimeters was examined. Diagnosis: placenta accreta.

Case 5. S.B., No. 42,077, aged 23 years, tripara, at term. The first child had been delivered by low forceps, the second, normal delivery. Patient had been delivered normally at 1:52 a.m., March 19, 1928. She bled profusely following delivery. The placenta did not separate. The uterus was explored; no definite line of cleavage was found. Bleeding ceased. One hour later manual extraction of the placenta was attempted. Only a small portion could be removed and the uterus was inverted during the process. Supravaginal hysterectomy was done, followed by a transfusion of 500 cubic centimeters of citrated blood. Second transfusion given of the same amount after operation. Patient died. Birth weight of infant 9 pounds, 6 ounces; discharged well.

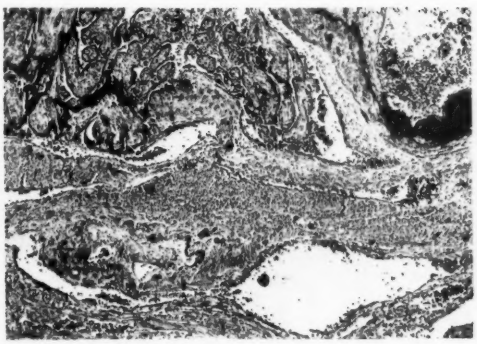

Fig. 6. Case 10. A full term complete placenta accreta. Eosin and methylene blue stain. (Same specimen as in Figs. 7, 12, 13, and 14.) ×37.

Villi and hyalinized trophoblast attached directly to myometrium. Nitabuch's stria and all decidual elements are absent. Rohr's fibrin stria irregular.

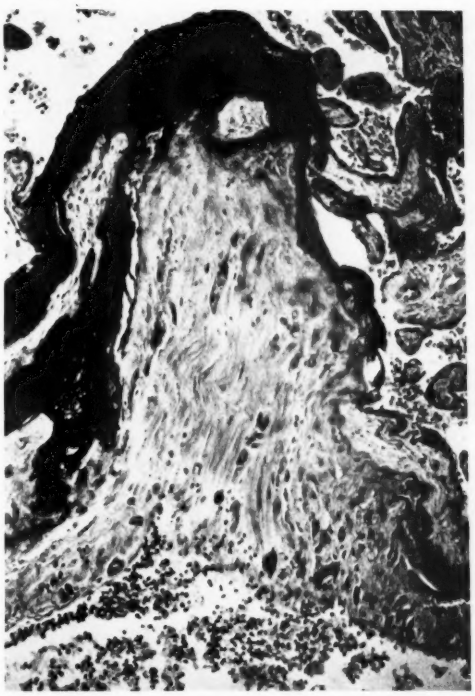

Fig. 7. Case 10. A full term placenta accreta. Eosin and methylene blue stain. (Same specimen as in Figs. 6, 12, 13, and 14.) ×110.

The base of this small placental septum is composed almost entirely of myometrium infiltrating which are a few trophoblastic cells. No decidual cells are present. A vascular sinusoid is present beneath the septum.

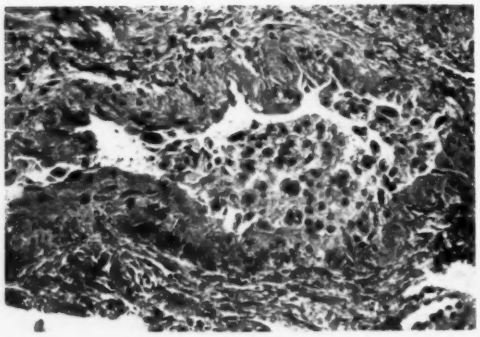

Fig. 8. Case 15. Chorionic epithelium in a vascular sinusoid 5 millimeters beneath the surface of the placental site. From an 18 weeks' complete cervical placenta accreta. ×110.

Diagnosis: complete placenta accreta; inversion of uterus.

*Pathological report.* B.C.H.Path. No. S-29-661. The specimen consisted of a full term postpartum uterus with placental tissue very intimately attached. The hyalinized layer of placental trophoblast, which showed calcification, was intimately fused with the myometrium. No trace of decidua basalis, either compacta or spongiosa, was found. Myometrium was not invaded and no fibrosis, inflammation, or degeneration of myometrium was noted at placental site.

Fig. 9. Case 18. A full term placenta from a case of partial placenta accreta. Hematoxylin and eosin stain. ×11.

This placental septum, measuring 2.2 centimeters in length, is composed of myometrium. The two adjacent cotyledons of the placenta are seen on either side of the septum. Aside from the fact that this muscular structure helps to anchor the placenta firmly to the uterine wall it indicates that placental septa in all pregnancies are composed, in part at least, of the tissue in which the ovum is embedded.

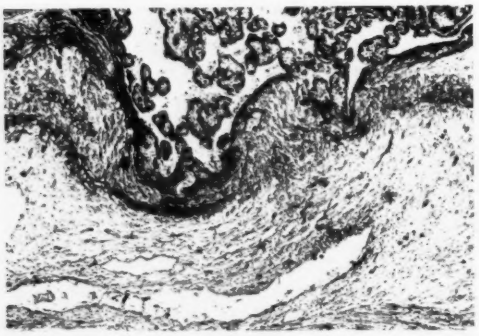

Fig. 10. A normal 32 weeks' placenta *in situ*. Hematoxylin and eosin stain. (Same specimen as in Fig. 11.) ×37.

Rohr's fibrin stria is clearly seen on the fetal surface of the trophoblastic layer (dark epithelium-like cells continuous with the villi) whereas Nitabuch's fibrin stria is clearly seen between the layer of trophoblast and decidua. The latter shows the usual division into compact and spongy portions. Near the center of the field the two fibrin striæ are tending to fuse, thereby becoming indistinguishable. This fusion often becomes more marked, as the placenta reaches maturity, because of the usual thinning and degeneration of the trophoblastic layer between the two striæ.

Case 6. B.M., No. 42,148, aged 30 years, quintipara, full term. Patient had 4 living children, the first delivered by forceps, the three others normally. She was delivered normally in out patient department at 4:55 a.m., April 1, 1929. The placenta was retained and there was considerable hemorrhage. Patient was transferred to hospital by ambulance. She was exsanguinated on admission and she was given 600 cubic centimeters of 5 per cent glucose and 500 cubic centimeters of citrated blood. Examination was done with patient under anesthesia. The placenta was found to be attached to the corpus of the uterus without a plane of cleavage. Supravaginal hysterectomy without drainage was done. Convalescence was afebrile and patient was discharged with infant on the seventeenth day. Birth weight of infant was 7 pounds, 9 ounces.

Diagnosis: complete placenta accreta.

*Pathological report.* B.C.H.Path. No. S-29-776. A full term postpartum uterus with grossly normal placenta firmly attached was examined. The decidua vera (Fig. 2) was thin, aplastic, and essentially aglandular (compare with Fig. 3, which shows normal decidua vera at full term), with many of the stromal cells resembling hypertrophied fibroblasts rather than true decidual cells. However, typical decidual cells were present. Beneath the decidua vera

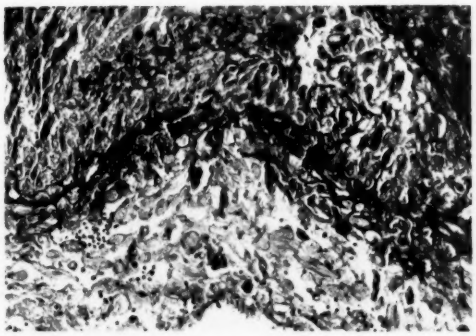

Fig. 11. Fetal trophoblast fused with maternal decidua from a 32 weeks' normal placenta *in situ*. Hematoxylin and eosin stain. ×110.

Rohr's layer is seen in upper right hand corner while Nitabuch's stria is seen between the trophoblast and decidua. (This is from the same field as in Fig. 10.)

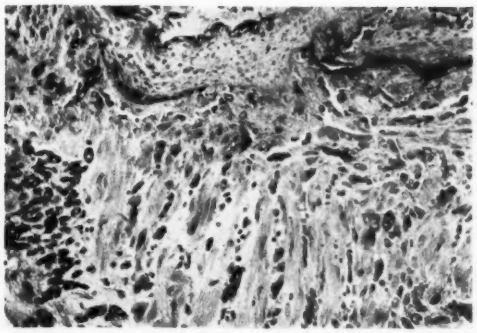

Fig. 12. Case 10. A full term placenta accreta. Eosin and methylene blue stain. (Same specimen as in Figs. 6, 7, 13, and 14.) ×110.

Villi in places attached directly to myometrium, which is infiltrated by uninucleated and multinucleated trophoblastic cells, the latter being the typical placental site giant cells. No decidual cells are present. Rohr's stria irregular. Nitabuch's stria absent.

was evidence of a moderate, perivascular, chronic inflammatory reaction. The placental site (Figs. 4 and 5) showed a deficient decidual reaction with the broad hyalinized band of placental trophoblast intimately fused with the otherwise normal myometrium. The best decidua present was at the margin of the placenta where there were also a few glands.

Case 7. F.B., No. 42,512, aged 45 years, quintipara, 4 normal deliveries, in thirty-seventh week of pregnancy. During the present pregnancy patient was admitted to the hospital for pyelitis and right hydronephrosis from April 6 to April 17, 1929. She was delivered normally in out patient department, May 27, 1929. The fetus was macerated, the placenta was retained, and there was free bleeding. Patient was transferred to the hospital by ambulance. She was in poor condition when admitted to the hospital—blood pressure 60/42. She was given a transfusion of 500 cubic centimeters of citrated blood and was examined under anesthesia. The placenta was found tightly adherent over a small area at the fundus. Supravaginal hysterectomy without drainage was done. A second transfusion of 500 cubic centimeters of citrated blood was given after operation. Convalescence was slightly febrile to the fourth day. She was discharged on the seventeenth day.

Diagnosis: partial placenta accreta.

*Pathological report.* B.C.H.Path. No. S-29-1309. The specimen consisted of a postpartum uterus with placenta attached firmly at two points, each 0.8 centimeter across. Microscopic section from one of these points of attachment showed muscle intimately fused to the maternal surface of the placenta. The muscle was chronically inflamed as were the immediately adjacent portions of the infarcted placenta. Nowhere was there chronic inflammation of the placenta except where this bit of myometrium was fused with it. There was no decidua in this region.

Case 8. E.S., No. 43,273, aged 36 years, duodecimpara, pregnant 38 weeks. Manual extraction of placenta was necessary following last three deliveries. Patient was delivered in out patient department at 3:45 p.m., September 9, 1929. Placenta failed to separate. She was transferred to the hospital by ambulance. On admission to hospital, pulse was 116; blood pressure, 85 systolic. Transfusion of 500 cubic centimeters of citrated blood was given and patient was examined under anesthesia. The placenta was attached to posterior wall of the corpus and was readily separated except at the upper portion which was firmly adherent. A second transfusion of

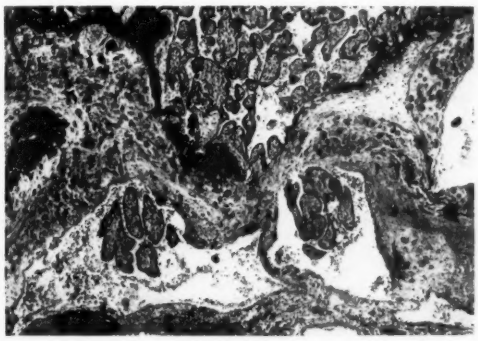

Fig. 13. Case 10. A full term complete placenta accreta. Phosphotungstic acid hematoxylin stain. (Same specimen as Figs. 6, 7, 12, and 14.) ×37.

Villi and hyalinized trophoblast attached directly to myometrium. Decidua and Nitabuch's fibrin stria absent. Rohr's stria present. Chorionic villi within vascular sinusoids, a non-pathological feature inasmuch as this is seen in normal placental implantations (see Fig. 1).

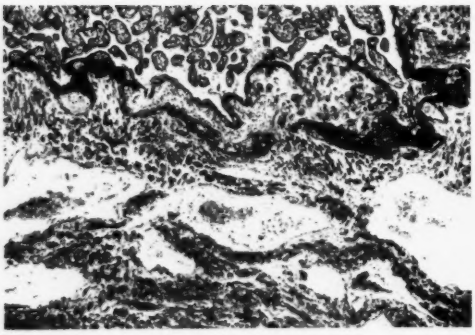

Fig. 14. Case 10. A full term complete placenta accreta. Phosphotungstic acid hematoxylin stain. (From same specimen as in Figs. 6, 7, 12, and 13.) ×37.

Note direct attachment of villi and hyalinized trophoblastic layer directly to myometrium. All decidual elements (and therefore Nitabuch's layer) are absent but Rohr's layer is present. Vascular development in myometrium beneath placenta is prominent in this region.

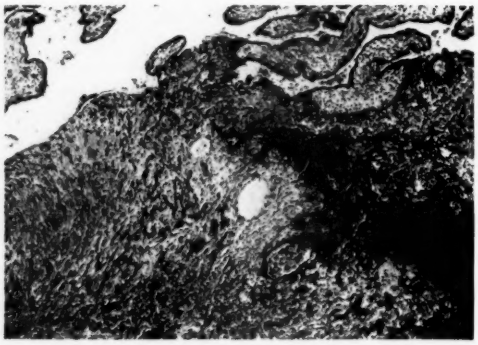

Fig. 15. A 16 weeks' incidental partial placenta accreta obtained by therapeutic hysterectomy. Phosphotungstic acid hematoxylin stain. (Case 1, incidental series.) ×37.

Compact decidua, containing a few glands, is seen to be associated with Nitabuch's fibrin stria while to the left, where the decidua is either absent or sparsely developed, the villi are attached directly to fibro-muscular tissue of the uterine wall.

the same amount was given. Supravaginal hysterectomy without drainage was done. Convalescence was afebrile. Patient was discharged with her infant on the seventeenth day. Birth weight of infant was 7 pounds, 6 ounces.

Diagnosis: partial placenta accreta.

*Pathological report.* B.C.H.Path. No. S-29-2230. A portion of the placenta with the uterine wall attached—8 by 5 by 2.5 centimeters—was examined. One slide showed mature placenta attached to and fused with the myometrium. Vascularity of placental site was of average type. No villi were noted in sinusoids. There was a broad layer of hyaline material in which were a few trophoblastic cells fused with the myometrium. This is a normal structure in a mature placenta. No decidua compacta or spongiosa in placental site. No glandular development was present. A few foci of lymphocytes but no true chronic inflammation, edema, fibrosis, or muscular degeneration of myometrium. Placental septa and decidua vera were not represented.

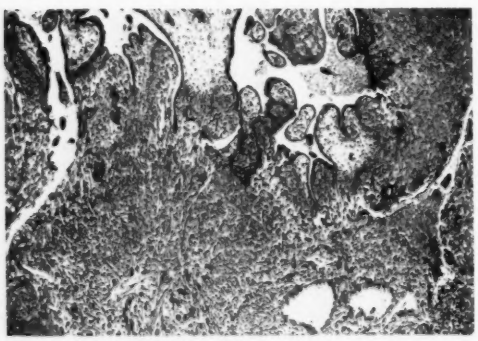

Fig. 16. Incidental partial placenta accreta, 16 weeks. Hematoxylin and eosin stain. (Case 2, incidental series.) ×37.

Note on the right the compact decidua and the two glands, the latter within myometrium. To the left of the middle the decidua, both compacta and spongiosa, is absent. The villi are embedded in or attached directly to the myometrium.

Case 9. C.N., No. U.H. 4,289, aged 34 years, octipara, at full term. On March 13, 1931, patient was sent to hospital by the family doctor for retained placenta. Her blood pressure was 68 systolic; pulse, 104. She was given 500 cubic centimeters of 10 per cent glucose and 750 cubic centimeters of citrated blood, after which the blood pressure rose to 100 systolic. She was examined under anesthesia. The placenta was found to be completely adherent to the anterolateral region of the corpus just above the cervix. Supravaginal hysterectomy without drainage was done. Convalescence was febrile to the ninth day. Hemoglobin was 55 per cent; 3,210,000 red cells on the sixth day. A transfusion of 500 cubic centimeters of citrated blood was given. Aside from a purulent bronchitis the patient from this time on made a good convalescence and was discharged with her infant on the twenty-third day. Birth weight of infant was 7 pounds, 7 ounces.

Diagnosis: complete placenta accreta.

*Pathological report.* H.M.S.Path. H-31-117. The decidua vera was scarred and contained but few true decidual cells. The decidua basalis showed portions of the compacta still present but rarely a gland and then only at the margin. A hyaline trophoblastic zone was intimately connected with the myometrium. No unusual invasion, fibrosis, inflammation, or degeneration of myometrium was noted.

There was one separated area at one margin where the decidua basalis was absent from both the uterine and placental surfaces.

CASE 10. M.B., No. U.H. 7,469, aged 27 years, quadripara, at full term. History revealed previous deliveries uneventful. March 18, 1932, patient was delivered precipitately in the out patient department. The placenta failed to separate. She was sent to the hospital by ambulance. Although patient had lost between 500 and 1000 cubic centimeters of blood there was no bleeding when she was admitted to the hospital. The blood pressure was 60/20; pulse, 100. She was given 1000 cubic centimeters of 5 per cent glucose solution intravenously and was examined under anesthesia. The placenta was found to be entirely adherent to the corpus of the uterus. A transfusion of 500 cubic centimeters of citrated blood was given. Supravaginal hysterectomy without drainage was done. Transfusion of the same amount of citrated blood was again given later in the day. Convalescence was febrile on the eleventh and twelfth days only, and patient was discharged on the nineteenth day postpartum with her infant. Birth weight of infant was 5 pounds, 8 ounces.

Diagnosis: complete placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-32-165. The specimen consisted of the supravaginally amputated postpartum uterus at term. The entire placenta was firmly attached to the posterior wall. The decidua vera was poorly developed grossly. There was partial separation at lower margin near the cervix. Decidua vera showed focal areas of fibrosis without glandular development but in general the spongy layer was not remarkable. The compacta had been stripped off. The decidua basalis showed a deficient compacta and spongiosa. In places villi were separated from muscle only by a fibrinoid layer or were directly embedded therein (Fig. 6). Trophoblast zone scanty. No unusual invasiveness was present. Vascularity was more marked than usual beneath the placenta. The placental septa were composed of an admixture of trophoblasts and smooth muscle (Fig. 7). Rohr's fibrinoid layer was irregular.

CASE 11. M.G., No. U.H. 8,500, aged 27 years, septipara, at full term. Last two pregnancies terminated in miscarriages at 6 and 3 months. Patient was delivered normally in out patient department at 4:45 a.m., July 23, 1932. The placenta failed to separate. Approximate blood loss was 300 to 500 cubic centimeters. Vaginal examination showed the placenta still attached to the corpus of the uterus on the posterior wall. Patient was sent to the hospital by ambulance. Under anesthesia the placenta was removed manually. Patient ran a septic course for 14 days from a streptococcus endometritis. She was transfused on the sixth postpartum day with 400 cubic centimeters of citrated blood. She was discharged with her infant on the twenty-fifth day. Birth weight of infant was 10 pounds, 7 ounces.

Diagnosis: partial placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-32-372. Gross: A 760 gram 15 by 13 by 3.5 centimeters circumvallate placenta in two large fragments was examined. The maternal surface was somewhat thicker than usual, averaging 0.5 to 1.0 millimeter. Microscopic examination revealed mature placenta with layer of negative myometrium intimately attached in two out of three sections. No spongy or compact decidua basalis was found except in one microscopic field in which there were 10 to 15 decidual cells surrounding a single gland in the base of a placental septum. The section without attached myometrium showed no compact decidua. There was no inflammation, trophoblastic invasion, or fibrosis, nor were villi present in sinusoids. The fibrinoid layer was sparse and irregular.

On October 25, 1933, patient re-entered the hospital 15 hours after rupture of the membranes. Because of unsatisfactory labor and her previous history a Kerr cesarean section and an Irving sterilization were performed and an 8 pound, 12 ounce infant was obtained. The placenta separated normally. Aside from a slight elevation of temperature on the first and second days, her convalescence was uneventful and she was discharged on the seventeenth day.

CASE 12. M.Z., No. U.H. 13,804, aged 35 years, nonipara, pregnant 36 weeks. First seven pregnancies had been normal. Last pregnancy terminated at 7 months by cesarean section because of antepartum hemorrhage, with loss of the fetus. Patient entered the hospital with ruptured membranes. Castor oil was unsuccessful in an attempt to induce labor. May 4, 1933, classical cesarean section was done. The uterus was attached to the abdominal wall and the bowel by many adhesions. Part of the placenta was adherent to the uterine scar of the old operation. Supravaginal hysterectomy without drainage was done. Convalescence was febrile to the eighth day. Patient was discharged with infant in good condition on the seventeenth day. Birth weight of infant was 5 pounds, 2 ounces.

Diagnosis: partial placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-34-212. The specimen consisted of a postpartum uterus, the seat of an old hysterotomy scar, 4.5 centimeters long and 0.5 centimeter wide, which was located 4 centimeters from the fundus and 2 centimeters from the cervical line of amputation. The uterine wall was 1.5 centimeters thick at the site of the scar in contrast to 3-3.5 centimeters elsewhere. Attached to the depressed, scarred area was a placental mass 5.5 by 3 by 1-1.5 centimeters. The decidua vera was grossly 1 millimeter thick. Microscopically, the decidua was completely absent over the endometrial aspects of the scar and the trophoblastic cells were inextricably fused with the scar by means of a heavy hyaline zone, the ordinary hyaline degenerated placental trophoblast. Muscle was present in the scar, which showed evidence of chronic inflammation in the form of perivascular lymphocytic infiltration. The decidua and the myometrium elsewhere were not remarkable.

CASE 13. V.P., No. U.H. 12,453, aged 38 years, nonipara, at full term. Both the seventh and eighth pregnancies were complicated by postpartum hemorrhage and failure of normal placental separation. Both times, however, the placenta was expressed by Credé's maneuver. At the end of this pregnancy the patient began to bleed freely. The attendant called in consultation a member of the hospital staff who advised that she be transferred to this institution. On admission, September 3, 1933, a classical cesarean section and supravaginal hysterectomy were performed and the bladder was accidentally perforated. The bladder was repaired. It was found impossible to separate the placenta from the cervical stump. The wound was closed to an abdominal drain and the patient was transfused with 500 cubic centimeters of citrated blood. The puerperium was febrile to the thirty-ninth day and was complicated by a pelvic peritonitis, pelvic and femoral phlebitis, bilateral pyelitis, and a vesicoabdominal fistula. She was discharged with her infant on the forty-eighth day. Birth weight of infant was 5 pounds, 10 ounces.

Diagnosis: partial placenta accreta; placenta previa.

*Pathological report.* B.L.I.H.Path. No. S-33-378. The specimen consisted of the postpartum uterus with two-thirds of the placenta, mostly on the anterior wall and spreading laterally on both sides toward the posterior lower uterine segment. Portions of the placenta could be detached and portions were firmly adherent. The one-third remaining in the cervix could not be digitally separated. The spongy portion only of the decidua basalis was present in one marginal area but otherwise both serotinal elements were absent. A broad zone of hyaline, degenerated trophoblast was intimately fused with the myometrium. There was no unusual invasiveness of the placental trophoblast. In their basal portion, the placental septa occasionally were composed of smooth muscle. Decidua vera was absent near the placenta and was normal at the fundus and corpus uteri.

CASE 14. E.I., No. U.H. 14,854, aged 33 years, primipara, at 37 weeks. The patient was known to have had hypertension before pregnancy. The eye grounds showed vessel sclerosis. A cesarean section was performed on December 11, 1934. The placenta did not separate spontaneously and an area of adherence to the posterior wall 3 by 4 inches in extent was found. The uterine wall was thin beneath this location. A supravaginal hysterectomy was performed with drainage through the cervix. The convalescence was afebrile to the thirteenth day but was later complicated by cystitis and an infected abdominal wound. The patient was discharged on the twenty-ninth day with her infant. Birth weight of infant was 4 pounds, 12 ounces.

Diagnosis: partial placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-34-625. Gross: Recent premature, postpartum uterus. The placental site measured 7 by 9 centimeters. Posterior and to the left it was shaggy, roughened, and showed small areas of placental tissue (largest 1 centimeter in diameter). Decidua vera was not remarkable. One small subserous leiomyoma 7 millimeters in diameter was found opposite the placental site and was not associated with placental tissue. The placenta weighed 340 grams, was lacerated and three probable areas of tissue were missing. Microscopic: The maternal surface of the placenta was thin and atrophic. Calcification was present but not significant. Uterus: The compact and spongy portions of the decidua basalis were absent in the areas of adherent placenta and poorly developed in others. Chorionic villi were present in vascular sinusoids. In one instance a villus was found embedded within the myometrium. The hyaline, trophoblastic layer was variable in development. The decidua vera was practically absent except for occasional areas surrounded by myometrium.

CASE 15. M.O., No. U.H. 11,193, aged 31 years, quadripara, 18 weeks pregnant. First two pregnancies were normal. The last pregnancy was complicated by hydrocephalic fetus, necessitating craniotomy, version, and extraction. Puerperium was complicated by endometritis. In this pregnancy there was vaginal bleeding for 4 days, with chills and a fever which rose to 105 degrees. Vaginal examination 5 days after entrance showed the os to be three fingers dilated and free bleeding was noted. A macerated fetus was extracted and more bleeding ensued, about 700 cubic centimeters of blood having been lost up to this point. The uterus was packed and the patient was transfused with 500 cubic centimeters of citrated blood. The pack was removed 18 hours later but as the bleeding was again severe the uterus was packed once more. About 6 hours later the uterus was explored and the placenta was found to be adherent to the posterior wall above the cervix. Attempts to remove the placenta with the curette and placenta forceps were unsuccessful. The patient was again given a transfusion and a supravaginal hysterectomy was performed on December 16, 1934, with drainage into the vagina through the cervix and through the vaginal wall. Patient was given a transfusion for the third time. Convalescence was febrile to the eighth day and was complicated by a septic abdominal wound. Patient was discharged on the thirty-fourth day.

Diagnosis: complete placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-34-645. Gross: The specimen examined consisted of 3 fragments of the placenta which were adherent to myometrium, the largest fragment being 9.3 by 3.0 by 1 centimeters. The decidua was firm, gray, and fibrous. Uterus: The uterine specimen consisted of a midterm, postpartum uterus with 2.3 centimeters of myometrium. The lower uterine segment, to a large extent posteriorly, was occupied by a foul, gangrenous, firmly adherent band of placental tissue 2.5 centimeters in width, extending practically around the entire circumference. The freshly cut surface of the placental site revealed a firm, fibrous union of placental and uterine tissue. Microscopic examina-

tion revealed no decidua vera, either compacta or spongiosa. The spongy portion of the decidua basalis was almost completely lacking. The compact portion was also poorly developed. The chorionic epithelium, in a large sheet and resembling that of an invasive mole, was in the myometrial sinusoids of the placental site (Fig. 8). There was no abnormal proliferation in the placenta itself. Much subacute inflammation was noted in the endometrium and the placental site.

CASE 16. M.S., No. U.H. 15,957, aged 29 years, sextipara, 18 weeks pregnant. Other pregnancies had been normal. Patient bled 4 days before she entered the hospital and she had bled as well every month in the present pregnancy. She had a miscarriage February 26, 1935, of twin pregnancy. She had no bleeding but the placentas were retained. An attempt was made at manual removal and with the blunt curette but some still remained on the posterior wall at the fundus. The uterus was packed. Eighteen hours later a supravaginal hysterectomy was performed with drainage through the stump and through the abdominal wall to both broad ligaments. Convalescence was afebrile. Patient was discharged on seventeenth day.

Diagnosis: partial placenta accreta, involving both afterbirths of double ovum twins. No similar case appears in the literature.

*Pathological report.* B.L.I.H.Path. No. S-35-161. Gross: Double ovum, twin miscarriage of macerated fetuses, 15½–16½ weeks of age. Uterine examination showed the uterus of midterm size, postpartum, with remains of partially but firmly adherent immature placentas on the anterior or posterior walls approximately midway between the fundus and cervix. The placental sites as well as the areas beyond were indurated, suggesting a chronic endometritis and myometritis with fibrosis. The decidua vera was thin and atrophic. Microscopic examination revealed acute and chronic inflammation of the endometrium. Practically no decidua vera or spongy decidua basalis was found. The villi were embedded either in the fibrous tissue or in muscle directly. No unusual invasion was noted. The typical chronic inflammation in fibrous tissue was noted between muscle bundles at placental site.

CASE 17. M.W., No. U.H. 16,606, aged 38 years, sextipara, at full term. First and last pregnancies had ended in miscarriages; others had been normal. The membranes had been ruptured spontaneously for 48 hours but the patient did not go into labor. There was considerable antepartum bleeding but no placenta was felt on vaginal examination. A Voorhees bag was inserted but labor did not supervene. A cesarean section and hysterectomy with abdominal drainage to the stump were performed on March 25, 1935. The patient had a very stormy convalescence with localized peritonitis but she was discharged from the hospital on the forty-third day. The infant weighed 7 pounds, 4 ounces and died immediately after birth.

Diagnosis: partial placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-35-265. Gross: The specimen was a postpartum uterus. The placenta was extremely large, covering much of the inner surface—18 by 19 centimeters—with multiple succenturiate lobes and, in addition, 1 large one measuring 9 by 4 centimeters. The latter was within 1 centimeter of the line of surgical excision. After fixation some areas seemed to be firmly adherent near the cervix while others were normally separable. Microscopic examination revealed no true spongiosa of the decidua basalis. There were occasional areas of decidua basalis compacta, however. One placental septum was fibromuscular in nature instead of trophoblastic or decidual. There was moderate, true, chronic infiltration of the placental site myometrium by perivascularly arranged plasma cells, lymphocytes, and monocytes. Some villi were embedded in the decidua compacta and others in the muscle. The decidua vera was completely deficient in spongy decidua and focally deficient in decidua compacta. There was acute inflammation of the placenta and membranes associated with the 84 hours of ruptured membranes.

CASE 18. E.N., No. U.H. 4,435, aged 21 years, tripara, at full term. Previous pregnancies had been uneventful. Patient was delivered normally May 20, 1935. Following delivery about half of the placenta was delivered to the vulva by Credé's maneuver. An attempt was made to extract the remainder manually. An area about 2 to 3 inches in diameter was found adherent to the right cornu, with no line of cleavage. Blood loss amounted to 600 cubic centimeters. Intra-uterine pack was inserted. Supravaginal hysterectomy was done with drainage through the cervix and through the abdominal wound to the stump. Transfusion of 500 cubic centimeters of citrated blood was given. The puerperium was febrile to the tenth day and from the twenty-first to the twenty-sixth day (pyelitis). Patient was discharged with infant on the thirty-sixth day. Birth weight of infant was 8 pounds, 15 ounces.

Diagnosis: placenta accreta.

*Pathological report.* B.L.I.H.Path. No. S-35-521. Gross: The specimen was a full term, postpartum uterus with myometrium 1.5–2.7 centimeters. In the right fundus, covering the ostium of the tube, was a mass of placental tissue 6.5 by 5.4 by 3 centimeters. This was subsequently shown to be a marginal extrachorionic cotyledon of a completely circumvallate placenta. The placental site at the fundus was partly anterior and partly posterior. Remains of spongy decidua with thrombosed sinusoids. The cotyledon could not be separated. Microscopic examination revealed absence of spongy decidua basalis. Rare, isolated, questionable decidual cells were found in the muscle just beneath the placenta. The placental septum was composed of muscle for 2 centimeters up into the placenta (Fig. 9). Muscle noted on dorsal aspect of the extrachorionic rim of the placenta instead of decidua. No fibrosis was noted in connective tissue stains. No inflammation was noted. The placental site from the manually

TABLE I.—BOSTON LYING-IN HOSPITAL CASES—CLINICAL SUMMARY

| | |
|---|---|
| No. cases | 18 |
| Complete | 6 |
| Partial | 12 |
| Average age, in years | 31.4 |
| Average parity | 5.6 |
| At term, per cent | 55.5 |
| Beyond 28 weeks, per cent | 77.7 |
| Implantation of placenta noted, cases | 18 |
| Corpus | 11 |
| Fundus | 2 |
| Cornu | 2 |
| Cervix (placenta previa) | 1 |
| Whole interior | 1 |
| Cesarean scar | 1 |
| Spontaneous hemorrhage in third stage of labor, per cent | 66.7 |

separated portion was poor in decidua spongiosa, whereas the placental site from the half which separated spontaneously showed normal decidua spongiosa of the decidua basalis.

*Clinical summary.* In Table I are given the leading facts concerning the status of our 18 clinical cases. All but one were multiparæ and over 75 per cent had passed the period of fetal viability. The placenta was abnormally situated in 7 instances. Spontaneous postpartum hemorrhage occurred in three-quarters of the cases.

*Etiology.* Six cases presented possible causative factors in previous pregnancies (Table II).

*Treatment.* In Table III are shown the results of different methods of treatment. The only patient who died (Case 5) had a complete placenta accreta which the operator attempted to separate and inverted the uterus in so doing. In spite of two transfusions and a hysterectomy the patient died of shock and hemorrhage. It is our present policy to prepare for a laparotomy whenever an adherent placenta is suspected. The uterus is explored under anesthesia and, if either a complete or partial placenta accreta is found, a hysterectomy is performed forthwith. Should bleeding be excited by this examination the uterus is firmly packed. The tampon is withdrawn just before the uterus is amputated.

The value of transfusion cannot be too strongly stressed. Twelve of our 18 cases received transfusions; 4 of them twice, and 1 three times.

*Summary of pathological findings.* Microscopic examination of the uteri removed from these women explains not only the failure of normal placental cleavage but also the hemorrhage attendant upon manual separation of an adherent portion. Since the picture in complete placenta accreta does not differ materially, except in extent, from that found in the partial variety, the same description will serve for both types. The decidua basalis is either entirely absent, or is represented merely by an occasional group of cells of the compact layer. Usually there is no spongy stratum whatever, but in some sections a rare gland or two may be found, although never in sufficient numbers to provide a plane of cleavage for separation. In 12 cases the decidua vera was also carefully examined, since its condition might be expected to provide a clue as to the general situation in the uterine mucosa when implantation of the ovum occurred. It was found to be normal in only 2 cases. We may assume, therefore, that the ovum at the time of its nidation was planted in a barren soil and was forced to attach itself to a partially denuded myometrium.

Bounding the maternal side of the normal intervillous space is the fibrin stria of Rohr. Beneath it, and developing at the junction of the trophoblast and the decidua itself, is the layer of Nitabuch, which is similar in appearance (Figs. 10 and 11). In placenta accreta the true Nitabuch's layer is poorly developed or absent, since its development is a function of the decidua, which is itself deficient. Rohr's

TABLE II.—BOSTON LYING-IN HOSPITAL CASES—POSSIBLE ETIOLOGY

| | Cases |
|---|---|
| Manual removal last 3 pregnancies | 1 |
| Retained placenta last 2 pregnancies | 1 |
| Miscarriages last 2 pregnancies | 1 |
| Miscarriage last pregnancy | 1 |
| Endometritis last pregnancy | 1 |
| Cesarean section last pregnancy | 1 |

TABLE III.—BOSTON LYING-IN HOSPITAL—TREATMENT

| | Cases | Deaths | Mortality per cent |
|---|---|---|---|
| Manual extraction | 2 | 0 | 00.0 |
| Manual extraction and pack | 1 | 0 | 00.0 |
| Partial manual extraction and supravaginal hysterectomy | 7 | 1 | 14.3 |
| Supravaginal hysterectomy with no attempt at extraction | 8 | 0 | 00.0 |
| Total mortality of series | 18 | 1 | 5.5 |

Received transfusions, 12, or 66.6 per cent of our cases.

layer may differ little from that found in any normal full term placenta, or, it may be less marked and irregular in extent. Beneath it and attached directly to the muscularis is an irregular layer of collagen-like material showing more or less hyaline and granular degeneration, containing a number of cells which are either single or in groups, and whose trophoblastic nature is indicated by the facts that they stain deeply and that some are multinucleated (Fig. 12).

Deep penetration of the villi, producing placenta increta, has not been a feature of our cases, nor have we noted the excessive thinning of the underlying uterine wall that so often accompanies it. We have, however, found villi which penetrate a certain distance into the myometrium and also into the myometrial veins. The entrance of villi into the maternal sinusoids is a picture not different from that found in normal implantations, where they often dip into the mouths of decidual veins. Since in placenta accreta there is no decidua, and consequently no decidual sinusoids, the villi enter instead the veins of the myometrium (Fig. 13). On occasions one finds an increased number of dilated veins in the superficial layers of the muscularis (Fig. 14). Should the placenta be separated manually by tearing across these vessels a severe hemorrhage will result.

Beneath the decidual septa of the normal placenta lies the same spongy decidua that in the normal state characterizes the whole basal layer. At the time of placental separation these septa separate at their bases from the myometrium and are cast off with the afterbirth. In placenta accreta, however, many of these septa show that muscle fibers have been drawn up into them for a considerable extent, thus providing even a more secure anchorage of the placenta to the uterine wall (Figs. 7 and 9).

Evidences of chronic inflammation of the decidua were found in 3 of our 5 cases of complete placenta accreta and in 3 of our 13 cases of the incomplete variety. In addition there was a certain amount of acute inflammation in 2 of our cases of partial accreta, both of which had been subjected to partial manual removal.

*Incidental placenta accreta found on histological examination.* Abstracts of the clinical data and pathological findings are given in 2 cases in which the uteri were removed for other causes. While we cannot predict that these cases would have developed clinical placenta accreta had they gone to term, it is nevertheless evident that the histological picture in each instance differs materially from that found in normal uteri at corresponding stages of pregnancy.

CASE 1. M.S., No. U.H. 9,734, aged 34 years, quadripara, at 14 weeks. First pregnancy was terminated by forceps; eclampsia and forceps delivery complicated second. Last pregnancy was complicated by toxemia and was terminated by cesarean section for generally contracted pelvis. Blood pressure in this pregnancy was 180/120; no albumin. Therapeutic abortion and sterilization by supravaginal hysterectomy was done January 14, 1935, for persistent hypertension.

Diagnosis: partial placenta accreta, incidental.

*Pathological report.* B.L.I.H.Path. No. S-35-39. Gross:The specimen consisting of the supracervically amputated, pregnant uterus containing a normal 16 weeks fundal pregnancy. Decidua vera and implantation site were grossly normal. Microscopic examination showed the decidua basalis deficient in areas, both as to compact and spongy portions. Occasional villi were attached to the fibromuscular tissue of the myometrium with little or no decidua between. At the margin the normal decidua vera changed into the focally deficient decidua basalis. The true Nitabuch's stria was focally deficient, corresponding to focally deficient decidua compacta (Fig. 15).

CASE 2. F.T., No. U.H. 7,700, aged 37 years, duodecimpara, at 16 weeks. All pregnancies had been normal except second and sixth which were miscarriages, and the last which was complicated by an afebrile phlebitis of both legs. A tuberculous kidney was removed 2 years ago, resulting in a sinus which was still draining and from which tubercle bacilli had been recovered. Patient was aborted and sterilized by supravaginal hysterectomy under spinal anesthesia with drainage through the cervical stump, on September 14, 1935. Convalescence was afebrile. She was discharged on the seventeenth day.

Diagnosis: partial placenta accreta, incidental.

*Pathological report.* B.L.I.H.Path. No. S-35-798. Gross: The specimen consisted of a supravaginally amputated pregnant uterus 11.5 by 13 by 9.5 centimeters. There was a normally implanted 16 weeks' ovum on the posterior wall of the corpus. The placenta measures 9 by 8 by 1.5 centimeters. No attempt was made to detach it. Microscopic examination revealed the decidua vera to be normally developed. The decidua basalis in general was nor-

TABLE IV.—CASES IN THE LITERATURE—SUMMARY

| Case No. Age | Author Year | Para | Weeks pregnant | Possible etiology | Delivery | Postpartum hemorrhage | Location of placenta | Complete or partial | Treatment | Transfusion | Result | Cause of death | Infant | Pathological examination Gross | Microscopic | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1<br>38 | Ahlfeld<br>1889 | 3 | | | Forceps | + | Fundus | C | Manual extraction | O | D | Peritonitis | D | + | O | Labor induced with bougie. Ruptured uterus |
| 2 | Hofmeier<br>1890 | | 40 | | Forceps | + | | C | Not removed | O | D | Hemorrhage | L | + | + | Placenta left in place. |
| 3<br>39 | Leopold and Leisse<br>1891 | 9 | 40 | Manual removal 3 previous pregnancies | Normal | + | Cornu | C | Manual extraction | O | D | Hemorrhage | | + | + | |
| 4 | Hink<br>1896 | 10 | | | Braxton Hicks | + | Cervix | C | Manual extraction | O | D | Pulmonary embolism | D | | | Placenta previa |
| 5<br>40 | J. Neumann<br>1896 | 3 | 40 | Manual removal 2 previous pregnancies | Bag and version | + | Cervix | C | Manual extraction | O | D | Hemorrhage | L | + | + | Placenta previa |
| 6<br>33 | v. Weisse<br>1897 | 5 | 36 | Manual removal last pregnancy | Braxton Hicks | + | Cervix | P | Vaginal hysterectomy | O | D | Peritonitis | D | + | + | Placenta previa |
| 7<br>25 | Alexandroff<br>1900 | 3 | 40 | | Hysterec-tomy | | Fundus | C | Abdominal hyster-ectomy | O | L | | D | + | + | Spontaneous ruptured uterus |
| 8<br>28 | Schwarzenbach<br>1900 | 1 | 16 | Fibroid | Normal | + | | P | Abdominal hyster-ectomy | O | L | | L | + | + | Placenta implanted on fibroid |
| 9<br>33 | Hense<br>1901 | 8 | 40 | Manual removal 2 previous pregnancies | Normal | + | Corpus | P | Manual removal | O | D | Hemorrhage | L | + | + | |
| 10<br>34 | Nordmann<br>1902 | 3 | 40 | Cauterization of uterus | Normal | + | Corpus | P | Manual removal | O | L | | L | + | + | Placenta only examined. Same condition next pregnancy |
| 11<br>23 | Nordmann<br>1902 | 2 | 40 | Manual removal last pregnancy | | + | Corpus | P | Manual removal | O | L | | L | + | + | Placenta only examined. Same condition next pregnancy |
| 12<br>26 | Meyer-Ruegg<br>1903 | 2 | 40 | Manual removal last pregnancy | Normal | | Corpus | C | Manual removal | O | D | Hemorrhage | | + | + | |
| 13<br>33 | Schwendener<br>1903 | 11 | 20 | Manual removal last pregnancy | Normal | + | Cornu | C | Manual removal | O | D | Hemorrhage | D | + | + | Vigorous Credé. Traumatic ruptured uterus |
| 14<br>32 | Kworostansky<br>1903 | 2 | 36 | Manual removal. Endometritis | Normal | + | Corpus | C | Manual removal | O | D | Hemorrhage | L | + | + | |
| 15<br>41 | Baueresen<br>1904 | 6 | 40 | Postpartum hemor-rhage. Endometritis | Normal | + | Fundus | C | Manual removal | O | D | Hemorrhage | L | + | + | Died 12th day following manual removal |
| 16<br>43 | Freund and Hitschmann<br>1905 | 10 | 20 | Manual removal last 2 pregnancies | Spontaneous abortion | + | | C | Manual removal | O | L | | D | + | + | Placenta removed 3 weeks after abortion |
| 17<br>35 | E. Martin<br>1906 | 3 | 40 | | Breech | + | Diverticu-lum | C | Manual removal | O | D | Hemorrhage | D | + | + | Placenta previa. Uterine diverticulum |
| 18<br>36 | Baisch<br>1907 | 9 | 40 | Manual removal last pregnancy | Vaginal cæsarean | + | Cervix | C | Vaginal hysterectomy | O | L | | L | + | + | Placenta previa |
| 19<br>31 | Wegelin<br>1907 | 2 | 24 | Manual removal last pregnancy | Normal | | Whole interior | C | Abdominal hyster-ectomy | O | L | | D | + | + | Flat rachitic pelvis |
| 20<br>27 | Holzapfel<br>1909 | 2 | 28 | Atmocausis | Normal | | | P | Manual removal | O | L | | D | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Bortkewitsch 1910 | | | | | | | P | Abdominal hysterectomy | O | L | | D | + | + | | |
| 22 | Bortkewitsch 1910 | | | | Cesarean | + | | C | Abdominal hysterectomy | O | D | Hemorrhage | | | | | |
| 23 34 | Breuer 1912 | 8 | 40 | Difficulty with separation 8 times | | | Uterine septum | C | Abdominal hysterectomy | O | L | | L | + | + | Uterus bicornis, subseptus unicollis | |
| 24 24 | R. Meyer 1912 | 2 | 16 | | Abdominal hysterectomy | | Fundus | | Abdominal hysterectomy | O | L | | D | + | + | Uterus and adnexa removed for pulmonary tuberculosis | |
| 25 31 | R. Meyer 1912 | 5 | 40 | Placenta previa 2nd pregnancy | Bag normal | + | Corpus | C | Vaginal hysterectomy | O | D | Hemorrhage | L | + | + | Uterus inverted in attempting manual removal | |
| 26 32 | Baumgart and Beneke 1913 | 4 | 40 | Atmocausis | Hysterectomy | | Whole interior | C | Abdominal hysterectomy | O | L | | D | + | + | Neglected transverse in labor 13 days. Placenta membranacea | |
| 27 39 | Vogt 1917 | 16 | 40 | | Breech | + | Cervix | P | Manual extraction | O | D | Hemorrhage | | + | + | Placenta previa | |
| 28 35 | Schmidt 1917 | 5 | 40 | | Version | + | Cervix | C | Manual extraction | O | D | Hemorrhage | | + | + | Placenta previa | |
| 29 38 | Schmidt 1917 | 8 | | 7 years ago placenta previa | Version | + | Cervix | P | Manual extraction | O | D | Peritonitis | | + | + | Placenta previa | |
| 30 39 | Schweitzer 1918 | 15 | 40 | Manual removal last 3 pregnancies | Braxton Hicks | + | Cervix | C | Vaginal hysterectomy | O | D | Hemorrhage | D | + | + | Placenta previa and diverticulum | |
| 31 24 | Proctor and Glascock 1922 | 1 | 40 | | Breech | + | Cornu | P | Abdominal hysterectomy | O | L | | L | | | | |
| 32 30 | Stephan 1922 | 6 | 40 | Manual removal 4 times | | + | Corpus | P | Abdominal hysterectomy | O | L | | L | + | + | | |
| 33 40 | Dietrich 1922 | 5 | 40 | Manual removal, curettage last pregnancy | Vaginal cesarean | + | Fundus | C | Manual removal | O | D | | | + | + | Spontaneous rupture of uterus | |
| 34 23 | Kratochvil 1922 | 3 | 32 | Manual removal 1st pregnancy | Abdominal hysterectomy | | Corpus | C | Abdominal hysterectomy | O | L | | | + | + | Spontaneous rupture after heavy lifting | |
| 35 30 | H. Neumann 1923 | 3 | 38 | | Cesarean | + | Cervix | P | Abdominal hysterectomy | O | L | | | + | + | Placenta previa | |
| 36 20 | H Neumann 1923 | 3 | 40 | | Cesarean | | Cervix | P | Manual removal | O | L | | L | + | + | Placenta previa | |
| 37 20 | Cooper 1924 | 2 | 40 | Curettage | Normal | + | Cornu | P | Manual removal | O | L | | L | | | | |
| 38 | Lehmann 1924 | 3 | 40 | Vaginal cesarean last pregnancy | Normal | + | Fundus | P | Manual removal | O | D | Hemorrhage | L | + | + | Uterine diverticulum | |
| 39 26 | Polak and Phelan 1924 | 1 | 28 | Fibroid | | O | Fundus | C | Abdominal hysterectomy | O | L | | D | + | + | Implanted on fibroid | |
| 40 31 | Andrews 1924 | 2 | 40 | Manual removal curettage, sepsis | Breech | + | | P | Manual removal | O | L | | D | | | | |
| 41 38 | Tennant, Wilson, Craig-Sullivan 1925 | 5 | 20 | Manual removal 3 times | Normal | | Whole interior | C | Manual removal | O | D | Sepsis | D | + | | | |

TABLE IV.—CASES IN THE LITERATURE—SUMMARY—Continued

| Case No. Age | Author Year | Para | Weeks pregnant | Possible etiology | Delivery | Postpartum hemorrhage | Location of placenta | Complete or partial | Treatment | Transfusion | Result | Cause of death | Infant | Pathological examination Gross | Microscopic | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42<br>38 | Albrecht<br>1925 | 3 | 40 | | | | | | Abdominal hysterectomy | O | L | | | | | Fetal ancephaly and eventration |
| 43<br>28 | Piccoli<br>1925 | 4 | 40 | Manual removal last 2 pregnancies. Sepsis | Breech | + | Corpus | P | Abdominal hysterectomy | O | L | | L | + | + | |
| 44<br>29 | Piccoli<br>1925 | 3 | 32 | Endometritis | Twins Normal | + | Corpus | P | Abdominal hysterectomy | O | L | | | + | + | Variety of twins not stated |
| 45<br>36 | Ecke<br>1926 | 1 | 36 | Fibroids | Normal | + | Fundus | P | Vaginal hysterectomy | O | L | | L | + | + | Portion implanted on fibroid. Multiple fibroids |
| 46 | Labhardt<br>1926 | 1 | 40 | Curettage | Normal | + | Fundus | P | Abdominal hysterectomy | O | D | Hemorrhage | | + | + | |
| 47 | Holzbach<br>1926 | 3 | 40 | Septic abortion and curettage | Breech | | Fundus | P | Abdominal hysterectomy | O | L | | | + | + | Uterine diverticulum. Traumatic ruptured uterus |
| 48<br>32 | Forster<br>1927 | 4 | | Manual removal last 3 pregnancies | Breech | + | Whole interior | C | Abdominal hysterectomy | O | L | | D | + | + | Toxemia |
| 49<br>24 | Reeb<br>1928 | 2 | 38 | Curettage | Cesarean | | Corpus | C | Abdominal hysterectomy | O | L | | D | + | + | Salpingitis in pregnancy. Hysterectomy and salpingectomy |
| 50 | Nathanson<br>1928 | 2 | | | | | | C | Abdominal hysterectomy | O | L | | | + | + | |
| 51<br>33 | Schwoerer<br>1928 | 5 | 28 | Curettage | Normal | | Fundus | C | Not removed | O | D | Peritonitis | | + | + | |
| 52<br>30 | Steinbiss<br>1928 | | 16 | | Abortion | + | Corpus | P | Manual removal | O | D | Hemorrhage | | + | + | Criminal abortion. Uterine diverticulum |
| 53<br>35 | Jackson<br>1928 | 2 | 40 | Postpartum hemorrhage last pregnancy | Forceps | + | Fundus | P | Abdominal hysterectomy | + | L | | L | + | + | |
| 54<br>27 | Kraul<br>1928 | 2 | 40 | Manual removal and sepsis 1st pregnancy | Normal | + | Corpus | P | Vaginal hysterectomy | + | L | | D | + | + | Menarche at 20 |
| 55<br>42 | Fruinsholz<br>1928 | 5 | 40 | | Normal | + | Corpus and cornu | P | Manual removal | O | L | | | | | Uterine drainage and Dakin's solution |
| 56<br>25 | Bakanow<br>1928 | 2 | 40 | Endometritis | Cesarean | | Cervix | C | Abdominal hysterectomy | O | L | | L | + | + | Placenta previa. Spontaneous rupture of uterus |
| 57<br>37 | Klaften<br>1929 | 7 | 40 | Manual removal last pregnancy | Normal | + | | P | Vaginal hysterectomy | O | L | | L | | | |
| 58<br>28 | Klaften<br>1929 | 3 | 40 | Two therapeutic abortions | Craniotomy | + | | C | Vaginal hysterectomy | | D | Hemorrhage | D | + | + | |
| 59 | Klaften<br>1929 | 3 | 10 | Curettage, 2nd pregnancy | Dilatation and curettage | + | Cervix | C | Curettage | O | D | Hemorrhage | D | + | + | Placenta previa |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60<br>35 | Klaften<br>1929 | 6 | 32 | | Normal | + | | C | Vaginal hysterectomy | O | L | | L | + | + | Hydramnios |
| 61<br>35 | Blagodarow<br>1929 | 8 | 28 | Manual removal last pregnancy | Vaginal cesarean | | Whole interior | C | Abdominal hysterectomy | O | L | | D | + | + | |
| 62<br>34 | Wilson<br>1929 | 3 | 40 | | Normal | + | Fundus | P | Removed with placental forceps | O | D | | | | | Gangrene of uterus and both legs |
| 63<br>25 | Sussig<br>1929 | 1 | 24 | | Spontaneous abortion | + | Fundus | P | Abdominal hysterectomy | O | L | | | + | + | Uterine diverticulum |
| 64<br>43 | Klostermann<br>1929 | 3 | 40 | | Breech | + | Cervix | C | Abdominal hysterectomy | O | L | | | | | Placenta previa |
| 65<br>28 | Kwartin and Adler<br>1930 | 2 | 40 | Sepsis following cesarean | Cesarean | | Corpus | C | Abdominal hysterectomy | O | L | | L | + | + | |
| 66<br>39 | Joachimovitz<br>1930 | 15 | 14 | | Abortion | | | C | Abdominal hysterectomy | O | L | | D | | + | |
| 67 | Joachimovitz<br>1930 | | | | Cesarean | | | P | Abdominal hysterectomy | O | L | | | | | Porro operation for osteomalacic pelvis |
| 68 | Joachimovitz<br>1930 | | 36 | | Normal | | | P | Vaginal hysterectomy | O | L | | | | | |
| 69<br>33 | Tiemeyer<br>1931 | 8 | | Retained placenta and sepsis last pregnancy | | | Fundus | C | Abdominal hysterectomy | O | L | | | + | + | |
| 70<br>35 | Giavotto<br>1932 | 7 | 40 | Postpartum hemorrhage last 3 pregnancies. Sepsis last pregnancy | Normal | | Corpus | P | Abdominal hysterectomy | O | L | | L | + | + | |
| 71 | Laffont, Ezes, and Xicluna<br>1933 | | 16 | | Normal | + | | C | Abdominal hysterectomy | O | L | | | + | | Positive blood culture before operation |
| 72 | Laffont, Ezes, and Xicluno<br>1933 | | 24 | | Normal | + | | C | Abdominal hysterectomy | O | L | | D | | | Infected uterus |
| 73<br>31 | Smith<br>1933 | 3 | 40 | Cesarean | Forceps | + | Whole interior | C | Manual removal | O | D | | L | + | + | |
| 74<br>41 | Solomons<br>1933 | 2 | 40 | | Cesarean | | | C | Abdominal hysterectomy | O | L | | L | | + | |
| 75<br>27 | Capecchi<br>1933 | 2 | 40 | Cesarean | Cesarean | | | C | Not removed | O | L | | D | | | Uterus adherent to abdominal wall. Placenta left in |
| 76<br>22 | Dorsett<br>1933 | 2 | 28 | | Normal | + | | C | Manual removal | O | L | | D | | | |
| 77<br>35 | Dorsett<br>1933 | 4 | 40 | | | | | P | Abdominal hysterectomy | + | D | Peritonitis | L | | | |
| 78<br>36 | Dorsett<br>1933 | 12 | 40 | | Breech | | | P | Abdominal hysterectomy | + | L | | L | + | + | |
| 79<br>38 | Phaneuf<br>1933 | 2 | 40 | Hemorrhage and sepsis, 1st pregnancy | Forceps | | Fundus | C | Abdominal hysterectomy | O | D | Ac. dil. of stomach | L | + | + | |
| 80<br>34 | Phaneuf<br>1933 | 3 | 39 | Retained placenta last pregnancy | Forceps | + | Corpus | P | Abdominal hysterectomy | + | L | | L | + | + | |

TABLE IV.—CASES IN THE LITERATURE—SUMMARY—Continued

| Case No. Age | Author Year | Para | Weeks pregnant | Possible etiology | Delivery | Postpartum hemorrhage | Location of placenta | Complete or partial | Treatment | Transfusion | Result | Cause of death | Infant | Pathological examination Gross | Microscopic | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 | Bansillon and Lyonnet 1933 | 6 | | Manual removal and sepsis last pregnancy | Version | | | P | Manual removal | O | L | | | | | Flat, generally contracted pelvis |
| 82 | Trelles Montes, Pages and Mulen 1934 | 7 | 36 | Endometritis | Normal | | | C | Abdominal hysterectomy | O | L | | L | | | |
| 31 | | | | | | | | | | | | | | | | |
| 83 | Trelles Montes, Pages and Mulen 1934 | 7 | 38 | Manual removal pregnancy before last. Sepsis | Normal | + | | C | Abdominal hysterectomy | O | D | Peritonitis | L | | | |
| 34 | | | | | | | | | | | | | | | | |
| 84 | Trelles Montes, Pages and Mulen 1934 | 4 | 40 | | Normal | + | | P | Abdominal hysterectomy | O | D | Peritonitis | | | | Septic on admission to hospital |
| 34 | | | | | | | | | | | | | | | | |
| 85 | Trelles Montes, Pages and Mulen 1934 | 7 | 40 | | | | | C | Abdominal hysterectomy | O | L | | | | | |
| 86 | Schockaert 1935 | 4 | 35 | Cauterization and cupping of cervix | Breech | | | P | Abdominal hysterectomy | O | L | | L | + | | |
| 34 | | | | | | | | | | | | | | | | |

mally developed but in occasional areas it was focally deficient as to both compact and spongy layers (Fig. 16). Rare glands in occasional areas were within the myometrium. Therefore, the trophoblastic cell columns of normal immature chorionic villi were directly attached to the myometrium in these regions but showed no unusual invasion thereof. The fibrin stria of Nitabuch was much better developed where there was trophoblast in contact with compact decidua, although occasionally small areas of hyaline eosinophilic material appeared between the trophoblast and myometrium. There was no evidence of fibrosis or chronic inflammation. Occasional vascular sinusoids in the placental site contained benign chorionic epithelium continuous with the trophoblastic layer of the placenta. No villi were within the sinusoids or myometrium.

## CASES IN THE LITERATURE

*History.* Although H. O. Neumann affirms that the first mention of placenta accreta was made by Justine Siegemundin, a midwife who flourished about 1690, the condition was previously described by Plater (1536–1614). He cites the case of Galla, a noble lady, who was delivered on March 25, in the year 88. The afterbirth was retained and the patient died. On opening the body the placenta was found to be firmly adherent about the internal os, thus indicating the additional presence of placenta previa. Placenta accreta was also described by J. R. Salzmann (1573–1656) and by Bonet (1620–1689). Morgagni (1682–1772) reports a case in which the patient died with the placenta undelivered after fever and rigors. At autopsy the placenta was found implanted partly over the internal os and partly at the fundus, and so firmly attached that it could be separated only with difficulty even with a knife.

In 1836, Simpson noted that in a few rare instances the whole placenta was connected with the uterus, although more commonly the adherence involved only a lobe or two. A series of authors who were influenced by histological examination began with Langhans' discovery in 1875 that placental separation takes place in the spongy layer of the decidua. D. Berry Hart, in 1889, arrived at the same conclusion without knowledge of Langhans' work and gave the first account of the microscopic picture of placenta accreta, stating that the spongy layer of the decidua was absent. In the same year Ahlfeld reported 13 cases of

retained placenta, of which one was evidently a true accreta. The patient died of peritonitis from perforation of the uterus caused by the insertion of a bougie to induce labor. At autopsy the placenta was found almost completely adherent to the fundus. No microscopic examination was made. In 1897 v. Weisse reported the first case in comparatively recent times associated with placenta previa. In v. Weisse's case a manual extraction was attempted and the patient died of hemorrhage. In 1890, Hofmeier reported a case in which no attempt was made at manual removal. The patient died of sudden hemorrhage and an autopsy was performed. Histological examination showed the placenta entirely adherent, the decidua basalis almost completely absent and the presence of fibrosis, which Hofmeier believed to be the cause of the adherence. In the year 1900 Alexandroff reported the first case to recover, although the diagnosis of placenta accreta was not made before operation. The patient suffered a spontaneous rupture of the uterus due to a weakening of the uterine wall from its perforations by in-growing chorionic villi. A hysterectomy was performed and the true nature of the condition discovered at that time. In the same year Schwarzenbach reported a placenta accreta implanted on a fibroid; failing in an attempt at manual removal he performed a hysterectomy and the patient lived. This patient was also the first primipara who appears in the literature.

Up to 1925, 40 cases of placenta accreta had been reported. Nineteen had lived and 21 had died. In spite of the good results obtained with hysterectomy by Schwarzenbach, Wegelin, Breuer, and others, manual extraction was performed in over half the cases. Twenty-two or 55 per cent were treated in this way. From 1925 to 1936, 46 cases appeared in the literature. Thirty-six patients lived and 10 died. Hysterectomy was employed in 36, or 78.3 per cent, of the cases.

*Clinical summary.* We have studied 86 cases of placenta accreta, which have been reported by 68 authors, and we believe that they represent a complete review of the literature. There are also cases cited by Joachimovitz and originally reported by Maelzer, Levy, Thulin, Amenta, Gough, and Peyssier in sources which are not available to us. The reports of these 6 authors have not been used in this paper. Cases 2, 3, and 4 of Jackson are the same as Cases 1, 2, and 4 of the Boston Lying-in Hospital series, but are again described for the sake of completeness.

The main clinical facts regarding these 86 cases are displayed in Table IV. Table V indicates the salient points concerning the status of these patients. As in our series it is seen that placenta accreta occurred most frequently among multiparæ in the middle of the childbearing period and that a majority had reached the period of viability. The placenta was implanted in the corpus in only 25 per cent of the cases.

*Etiology.* A possible cause for placenta accreta occurred in the past histories in 37, or 43.0 per cent of the 86 cases (Table VI). Previous manual extraction occupied the first place, having been performed in 19 cases. Although the trauma and possible infection provoked by this maneuver may have had some bearing on the development of placental adherence in the later pregnancy, it is even more probable that these earlier extractions were caused by the same pathological deficiency of the decidua that led to the final result. Curettages had been performed in 10 patients. Schockaert calls attention to the injury produced by the so called thorough curettage, which removes so much endometrium that little is left for regeneration. When the *cri uterin* is elicited throughout the interior of the uterus it indicates that all of the mucosa has been scraped off, since this grating sensation is elicited by the passage of the instrument over the denuded muscle bundles. Atmocausis, or the application of steam to the uterine cavity, is reminiscent of the more robust days of gynecology, now happily past.

*Complications.* Aside from the case of spontaneous *rupture of the uterus* reported by Alexandroff and already mentioned, others were cited by Dietrich, Kratochvil, and by Bakanow. Traumatic ruptures were recorded by Holzbach and by Schwendener. Schwendener describes a case in which the placenta was extruded into the peritoneal cavity by

TABLE V.—CASES IN THE LITERATURE—CLINICAL SUMMARY

| | |
|---|---|
| No. cases | 86 |
| Complete | 47 |
| Partial | 37 |
| Not stated | 2 |
| Average age, years | 32.5 |
| Average parity | 4.7 |
| At term, per cent | 66.7 |
| Beyond 28 weeks, per cent | 86.6 |
| Implantation of placenta noted, cases | 64 |
| Corpus | 16 |
| Fundus | 18 |
| Cornu | 5 |
| Cervix (placenta previa) | 13 |
| Whole interior | 6 |
| Diverticulum | 5 |
| Cornu and septum (uterus bicornis subseptus unicollis) | 1 |

TABLE VI.—CASES IN THE LITERATURE—POSSIBLE ETIOLOGY

| | Cases |
|---|---|
| Manual removal | 19 |
| Once | 7 |
| Twice | 2 |
| Thrice | 3 |
| Four times | 1 |
| Eight times | 1 |
| Manual removal and curettage | 2 |
| Manual removal and endometritis | 1 |
| Manual removal, cauterization and dry cupping | 1 |
| Manual removal and placenta previa | 1 |
| Curettages | 10 |
| Curettages alone | 8 |
| Curettages and multiple cauterizations | 1 |
| Curettage and removal of placental polyp | 1 |
| Atmocausis | 2 |
| Endometritis | 4 |
| Sterility for 8 years | 1 |
| Previous cesarean section | 1 |

the vigorous use of Credé's maneuver. *Uterine diverticula* appeared as contributing factors in the cases of Holzbach, Steinbiss, Sussig, and Lehmann. Lehmann's case of irregularity in the shape of the uterus at 3 months led to an exploratory laparotomy on the suspected diagnosis of extra-uterine pregnancy. Sussig's case, occurring in a primipara, indicates a congenital origin. *Placentæ previæ* were found by Hink, J. Neumann, v. Weisse, E. Martin, Baisch, Vogt, Schmidt (2 cases), Schweitzer, H. O. Neumann (2 cases), Bakanow, Klaften, and Klostermann. Breuer reported the implantation of a placenta accreta upon the septum of a uterus bicornis subseptus unicollis. Baumgart and Beneke and Dietrich found placenta membranacea. The patient of Froriep as reported by R. Meyer had suffered *inversion of the uterus* during the attempt at manual extraction. Reeb's patient had an *acute salpingitis* during pregnancy. An exploratory laparotomy was performed and pus was found exuding from the left tube. A hysterectomy was done and both tubes and the left ovary were removed. The only example of *fetal abnormality* was reported by Albrecht. The infant had anencephaly and eventration. Likewise, the sole case of *twins* was that of Piccoli. The author does not state whether there were two separate placentas, or if the afterbirth was single or composed of two fused structures. Klaften's fourth case had *hydramnios*. Wilson reports a case in which the patient died of *gangrene of the uterus* and both legs 12 days after delivery. At autopsy an unsuspected partial placenta accreta was found. Baumgart and Beneke report a case of a patient, who, according to their account, was in labor for 13 days, the last 9 under morphine. The infant was stillborn, but the mother lived following a hysterectomy performed after extraperitonealizing the uterus.

*Treatment.* In Table VII are given the methods of treatment employed in the cases reported in the literature. It is significant that of the patients who were subjected to supravaginal hysterectomy without any attempt at manual extractions none died, whereas when manual extraction alone was carried out 64.5 per cent succumbed. In 3 patients the placenta was left in the uterus; 2 of them died, a death rate of 66.7 per cent. The sole survivor was the patient of Capecchi. A cesarean section with a transverse fundal incision has been performed in a previous pregnancy. At the end of the current pregnancy, the membranes ruptured. After waiting 3 days and until the temperature had risen to 104 degrees, the pulse to 140, and the fetus was dead, Capecchi decided to remove the uterus. When an attempt was made to open the peritoneal cavity the incision entered the uterus which was densely adherent to the abdominal wall. The fetus was extracted, but it was impossible to remove the placenta. A drain was placed in the uterine cavity and 2 days later a further attempt was made to separate the afterbirth, again without suc-

TABLE VII.—CASES IN THE LITERATURE—TREATMENT

| | Cases | Deaths | Mortality per cent |
|---|---|---|---|
| Manual extraction or curettage. | 31 | 20 | 64.5 |
| Partial manual extraction and vaginal hysterectomy..... | 11 | 4 | 36.4 |
| Partial manual extraction and supravaginal hysterectomy... | 30 | 6 | 20.0 |
| Supravaginal hysterectomy with no attempt at extraction.... | 11 | 0 | 00.0 |
| Not removed..... | 3 | 2 | 66.7 |
| Combined mortality of series... | 86 | 32 | 37.2 |

cess. This remarkable woman left the hospital in 2 months and the author assures us that she was menstruating regularly.

The first transfusions mentioned in the literature were those of Jackson and of Kraul, both reported in 1928. The only others described were in the 2 cases of Dorsett and one of Phaneuf, making 5 in all. The infrequency of transfusion, particularly in later years when it has become a simple procedure, is difficult to understand.

The combined mortality in the 86 cases was 37.2 per cent.

*Summary of pathological findings.* Absence of the whole decidua basalis was noted by Nordmann, Bauereisen, Wegelin, Meyer-Ruegg, Schwendener, Bortkewitsch, Vogt, R. Meyer, Schmidt, Schweitzer, Kratochvil, Klostermann, Kraul, Lehmann, Piccoli, Stephan, Steinbiss, Tiemeyer, Forster, Reeb, J. Neumann, Sussig, Holzbach, Ecke, Blagodarow, Alexandroff, Kwartin and Adler, Dietrich, Phaneuf, Klaften, Polak and Phelan, Freund and Hitschmann. Hofmeier, Baumgart and Beneke, E. Martin, H. Neumann, Hense, Breuer, and Jackson found it almost completely absent. Bakanow found it never abundant, while Kworostansky reported that there was some basalis present. Leopold and Leisse found it mostly absent and replaced by connective tissue, while Bortkewitsch, in his second case, reported it to be still present.

Absence of the compact layer was noted by Schweitzer and by Dietrich. Schwarzenbach and Dorsett found it to be scanty.

The spongy layer was found to be lacking by Kworostansky; Kraul; Schweitzer; Schwarzenbach; v. Weisse; Leopold and Leisse; Nathanson; Schwoerer; Dorsett; Baisch; Dietrich; Klaften; Joachimovitz.

Penetration of epithelial cells, probably of a trophoblastic nature, was noted by Kworostansky, Kraul, Schmidt, Schweitzer, Schwendener, Steinbiss, Wegelin, Vogt, H. Neumann, Meyer-Ruegg, Polak and Phelan.

Deep penetration of chorionic villi into the uterine wall was noted by Klostermann; Laffont, Ezes and Xicluna; Stephan; Tiemeyer; Forster; Smith; Reeb; R. Meyer; Tennant, Wilson, and Craig-Sullivan; Sussig; Hense; Breuer; Holzbach; Blagodarow; Baumgart and Beneke; Klaften; Polak and Phelan. Kratochvil, Lehmann, and H. Neumann found the villi in contact with the peritoneal coat, while Bakanow, Schweitzer, Bortkewitsch, and Alexandroff noted perforation of the uterus. Deep penetration into the veins was found by Kworostansky, J. Neumann, Piccoli, Schmidt, Bauereisen, Kwartin and Adler, and Phaneuf. On the other hand, Nathanson states that he did not find any deeper penetration into the uterine wall than one would encounter on study of the normal placental site.

Thinning of the uterine wall beneath the placental site was noted by Kratochvil and by Reeb. J. Neuman, Tiemeyer, Schockaert, and Polak and Phelan described it as very thin, Holzbach as paper-thin, and E. Martin stated that he could feel the intestines through it. The actual thickness of the uterine wall was given by a number of observers as follows: Schmidt (second case), ¼ millimeter; Kworostansky H. Neumann, 1 millimeter; R. Meyer (second case), ½ to 1 millimeter; Kwartin and Adler and Dietrich, 1 to 2 millimeters; Wegelin, 1 to 3 millimeters; Schwendener, Sussig, 2 millimeters; Baumgart and Beneke, 2 to 5 millimeters; Smith, 2 to 3 millimeters; R. Meyer, 2.5 millimeters; Stephan, Vogt, Bauereisen, 3 millimeters; Schmidt (first case), and Schwoerer, 4 millimeters; Klaften 4 to 5 millimeters; Kraul, 5 millimeters, Meyer-Ruegg, 6.5 millimeters; Blagodarow, 7 millimeters; Nathanson, 2 centimeters; v. Weisse, 2.5 centimeters; Ecke, 36 millimeters.

Changes in the so called hyaline layer of Nitabuch were noted by a number of authors. Baisch reported it as normal; Vogt as evident; Schmidt, Stephan, Ecke, as well developed; Lehmann, Meyer-Ruegg as broad; Bauereisen, Dietrich as continuous; and R. Meyer as not noteworthy. On the other hand, Breuer, Baumgart and Beneke describe it as scanty; Dorsett, Kwartin and Adler as thin in places; Schweitzer, Wegelin, Klaften and Jackson as irregular; and Phaneuf as broken through. Observations on the behavior of Nitabuch's layer have little value, since there has been a universal failure to distinguish this stratum from that of Rohr. As we have stated previously Rohr's layer bounds the intervillous space while that of Nitabuch develops at the junction of decidua and trophoblast.

Few authors have made the important observation that myometrial tissue has been drawn up into the decidual septa. Those who observed this phenomenon were Schmidt, Wegelin, H. Neumann, and Klaften.

Degeneration of the myometrium was noted by Reeb, Bauereisen, H. Neumann, Sussig, Kwartin and Adler, Dietrich, Klaften, Bakanow, Kworostansky, and Schweitzer. Meyer-Ruegg described it as hyaline and Kraul as fibrinoid.

Evidences of chronic inflammation were found by E. Martin, and of acute infection by Bauereisen.

Increased connective tissue formation was described by Nordmann, Schwendener, Leopold and Leisse, Hofmeier, Baisch, and Joachimovitz.

Only 21 authors have described the condition of the decidua vera, which may be the key to the situation in the endometrium before implantation occurred and may throw light on the cause of placenta accreta. Lehmann, J. Neumann, Schmidt, Wegelin, Breuer, and Dorsett described it as normal. Blagodarow and Dietrich found it completely absent, while Kraul, Schweitzer, Reeb, Vogt, R. Meyer, H. Neumann, Hense, Kwartin and Adler, and Phaneuf found it poorly developed. Sussig noted the spongy layer to be deficient, while Baisch and Klaften found it absent.

*Theories.* The older authors who speculated on the cause of placenta accreta believed that it was due to inflammation. Simpson, as the chief exponent of this hypothesis, believed that such infection might originate in the uterus, the placenta, or both. According to Schweitzer, Ramsbotham, Brachet, d'Outrepont, Stratford, and Hegar held similar views. However, as more microscopic examinations were made, it became evident that inflammation was not the determining factor and that when present it was only an incidental finding. Although Hegar believed that bleeding in the early months of pregnancy might lead to organization of the blood clot and eventual fibrosis, a study of the histories of patients with placenta accreta failed to show an increased incidence of threatened abortion. Veit advanced his theory of deportation of the villi by way of the blood stream. He believed that these chorionic elements found their way deeply into the veins of the uterus and that the uterus and the egg grew together at the same time. R. Meyer believed that when the placenta was implanted in a region where there was little opportunity for lateral growth, such as over the internal os or over a fibroid, the chorionic villi made up for this deficiency by penetration into the muscularis. Reeb considered that the villi entered the myometrium either because the decidua was not normal or because the villi had an increased power of penetration. This power might be due to a deficiency in an antiferment which this author believes resists the normal penetrating power of the villi.

The latest theory regarding the cause of placenta accreta, involves, as one might expect, the endocrines. Schockaert considers that faulty implantation results from imperfect development of the mucosa and that this may be due to lack of progestin, or corpus luteum hormone. He hastens to admit, however, that injury to the endometrium by trauma or infection, plays a major part.

J. Neumann believed that at the beginning of pregnancy the decidua was normal but became atrophied as gestation progressed. There is considerable evidence, however, both from the cases in the literature and our own observations, to indicate that the decidua vera, which is not concerned with the placenta, is frequently deficient in amount or in structure. If we may assume that this condition held at the beginning of pregnancy, we may postulate a similar situation in the decidua basalis.

## SUMMARY AND CONCLUSIONS

1. Eighteen clinical cases of placenta accreta are reported, and 86 others described in the literature are reviewed.

2. The incidence in our clinic has been 1 case in every 1,956 deliveries. We believe that many cases of partial placenta accreta escape attention, since reports in the literature indicate that the complete variety outnumbers the partial 9 to 7, while our experience shows the ratio to be 1 to 2.

3. The essential cause of this condition is partial or complete absence of the decidua basalis, so that the placenta is attached directly to the myometrium.

4. In 12 of our cases the decidua vera was also examined and found to be normal in only 2 instances, thus indicating a generally defective development in the endometrium when the ovum was implanted.

5. Supravaginal hysterectomy with no attempt at manual extraction of the placenta produces excellent results, since of the 19 cases in the literature and in our series so treated, no mothers died.

6. Manual extraction of the adherent placenta is extremely dangerous. Of the 30 cases in the combined series where this procedure was effected 20, or 66.6 per cent, died.

7. Transfusion should be employed in every case in which the blood loss exceeds, even by a small amount, the normal limit.

8. In the 86 cases from the literature the maternal mortality was 37.2 per cent. In our 18 clinical cases the death rate was 5.5 per cent.

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# THE INITIATING LESIONS OF RENAL CALCULUS

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IT would be presumptive for me, at this time and before this audience, to tax your time and patience in an exposition of our common knowledge on the origin of renal calculus. We are all equally familiar with the historical background, and we are all equally familiar with the pertinent theories now held as possible etiological factors—infection, stasis, avitaminosis, colloidal imbalance, hyperparathyroidism. That each of these theories gives us plausible ideas as to how a stone *might* form will be admitted. But medicine, as a whole, demands actual facts, and wishes to know how a stone *does* form; and no research work to date, with which I am familiar, actually tells us how a stone originates, where it starts, how it starts, or why it starts. There seems to be an enormous hiatus in our knowledge between theory on the one hand and frank outspoken facts, as met in the clinic, on the other hand. Likewise, I am certain that many of you have asked yourselves pertinent questions in regard to stone origin which you could not answer, and which the various theories fail to explain: From what does a stone take origin? Where does it first arise? How does it grow? Why is it for a time stationary? Why are stones so often found in only one kidney? And why, when certain theoretical morbid states exist, does it fail to occur? That there is a distinct dearth of knowledge of what I might term the embryonic growth of a stone seems to be outstanding, for nowhere does one find any research which traces from an original lesion the gradually added increment of salt deposit which, in time, accumulates from what must be a microscopic origin to larger and larger size that becomes macroscopic, and develops still further to the point at which roentgen-ray detection finds it, or at which it makes itself manifest by starting a train of drastic clinical symptoms leading to the operating table.

From the Department of Urology, University of Pennsylvania and the Abington Memorial Hospital. Delivered before the American Association of Genito-Urinary Surgeons, at Stockbridge, Massachusetts, May 26, 1936.

When one contemplates this picture from these various aspects, or when one asks oneself questions bearing on this period of silent, asymptomatic growth, it becomes almost a foregone conclusion that a stone must originate from some form of primary lesion that antedates salt deposition, and during this period of what I have termed its embryonic growth, it must be adherent to some part of the renal pelvic structure and, in such a static state, grow in silence to what might be called its full term, or maturity. Questions can also be asked for an explanation as to why one man may produce a stone of one chemical composition, and another man produce one of an entirely different salt deposit; which again is a question which no theory today competently explains. It is thoughts such as these, and our inability to answer them satisfactorily, that have made me formulate a hypothesis that all renal calculi must have, as a point of origin, some lesion pre-existing in the pelvic portion of the kidney. When such a hypothesis is, in its turn, examined as to where such a lesion would, or could, occur, it becomes again a matter of simple deduction that such must have its origin on a renal papilla or the wall of a minor calyx. Therefore, in offering a hypothesis for the origin of stone, these two postulates were formulated and they have presented the basis for a series of research problems in an effort to prove or disprove their accuracy: *first, that an initiating lesion had to exist; second, that any such lesion should be sought for on the renal papillæ, or close thereto.*

Let it be understood that only such stones as occur as primary renal calculi are under consideration in this study and that we are not concerned with those stones that originate as secondary to various obstructive uropathies. Likewise, it might be observed that we are essentially interested in the smallest type of primary stones—those which are of recent growth and uncomplicated in the clinical sense—and this in order to arrive at the

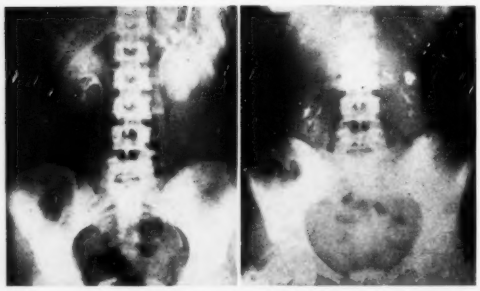

Fig. 1. Urograms with patient in supine and erect positions. There is a large stone in the superior calyx of the left kidney. Note that an obstructive uropathy does not exist. Likewise, there was no infection present. Compare with postmortem specimen in Figure 11.

Fig. 2. Scout plate showing three distinct shadows in left kidney region, and urogram showing that each occupies a minor calyx. This patient has passed four calculi from this left kidney and one from the opposite one. Cultures were negative, and there is no obstructive nephropathy.

basic etiological factors in the simplest form that calculus occurs.

First, it has been a matter of constant observation to find repeated evidences, on roentgen-ray examination, that most small calculi are found in the region of the renal papillæ. On excretion urography such shadows are easily proved to be in a minor calyx. Figure 1 exemplifies such a case in the superior calyx, and Figure 2 shows three shadows, each of which is similarly located in a minor calyx when the pelvic outline is obtained by excretion urography. This observation is quite familiar to urologists and roentgenologists, I am sure, but I do not believe its relationship to stone origin and the primary seat of growth has been given its true and full interpretive value. This observation is, of course, only suggestive of the location at which a primary stone originates, but such illustrative plates can be bountifully multiplied from anyone's experience.

Second, when small renal calculi, whose clinical existence has been of short duration (as judged by the patient's history), are closely studied with hand lens, they invariably have been proved to present on one side a uniform crystalline growth, while on the opposite surface is to be found a facet indicative of mural attachment. Figure 3 is such a stone, showing its facet. Twelve such small calculi have been hemisectioned and polished, and Figure 4 is such a cross section, showing not only the highly crystalline periphery but the definite surface where mural attachment existed. It is of moment to point out that the facet in this specimen appears as a sunken area, with an encroachment and redundancy of the crystallization all about its edges. This is of importance, as will be shown later.

The above evidences of the location of the origin of renal calculi and the suggestive signs from our study of the stones themselves have been repeatedly observed over a period of years, and have been the stimuli for certain experimental studies aimed toward the creation of an artificial initiating lesion.

During the past 6 years 7 different research problems have been formulated and tried, in an effort to prove the accuracy of the 2 postulates. Without troubling you with their details, I might state that they were all directed toward the creation of a lesion on which a renal stone would develop. These experiments were performed on lower animals, and all have failed of their purpose. In our simple line of thought, the initiating lesion which was the easiest to conceive of as existing was an ulceration on a papilla, and failing in our ability to create such in the lower animals or, if created, consistently to cause renal stone to grow brought to a close these chapters in our experimental researches.

With this failure of purpose in the production of stone in experimental animals, I next decided to turn to the autopsy table and, by following a large group of autopsies, to hope that I would chance upon lesions of the papilla which perhaps could be related to the secondary deposit of urinary salts. To date (May

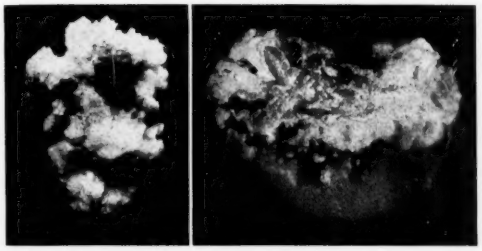

Fig. 3, left. Photograph of a tiny calculus passed from right kidney and ureter after one cystoscopic dilatation of the ureteral orifice. Original calculus measured 4 by 6 millimeters. It clearly shows its facet of mural attachment, surrounded by highly crystalline growth.

Fig. 4. Hemisection of small calculus passed voluntarily after two sharp ureteral colics. The calculus measures 3 by 8 millimeters, and the sectioned surface has been polished. It shows the crystalline periphery, the area of mural attachment, and especially the encroachment of crystalline growth about the area of mural attachment which ultimately detaches the stone from its point of growth. (See Fig. 10.)

1, 1936) the kidneys from 104 autopsies have been so examined, and in this work I have had the co-operation of the pathologists in two hospitals, who have permitted me to have all kidneys before they were even opened.[1] In each and every case the pelvis has been opened first, and each minor calyx, with its papilla, has been closely examined with hand lens for evidence of pathological change. Of this group of 104 autopsies I wish to report that 12 have presented evidences which constitute the material for this preliminary report.

First, let me state that evidences of ulceration and infection have not been found to date. Second, one interesting case of a simple cyst of the papilla has been found. Third, we have come upon 12 cases presenting an unusual picture and a new pathological lesion. This lesion may be described as follows: On the papilla, generally on its lateral wall, or near its tip, is seen an area, which, for lack of a better term, I have called a "milk patch." It may be, in size, anywhere from the tiniest possible dot to an area measuring 2 or 3 millimeters in diameter. It may be sharply outlined or delicately stellate in appearance (Fig. 5). It may be of uniform consistency, though some have shown centers which appear as

[1]The author wishes to acknowledge the stimulating and hearty co-operation of Dr. Edward B. Krumbhaar, professor of pathology; Dr. Balduin Lucke, professor of pathology; Dr. O. Norris Smith, resident pathologist; and Dr. Perry D. Melvin, fellow in urology, of the Hospital of the University of Pennsylvania; and of Dr. John Eiman, director of the department of pathology; Dr. Julius Foldes, resident pathologist; and Dr. Edward W. Campbell, associate urologist, of the Abington Memorial Hospital.

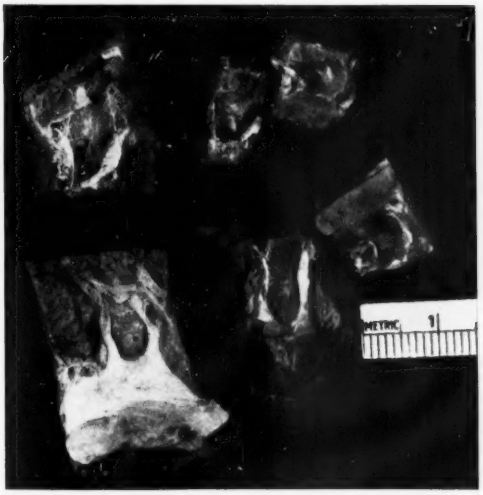

Fig. 5. Six papillæ from different kidneys, each with its minor calyx opened, and each showing the characteristic "milk patch." The location is rarely on the actual tip of the papilla and it is definitely a subsurface deposit. This is an original observation in relation to renal calculus formation. The specimen in the lower left corner shows a secondary black surface deposit upon an underlying "milk patch," probably the earliest observed evidence of the initiation of renal calculus growth. (See Fig. 7.)

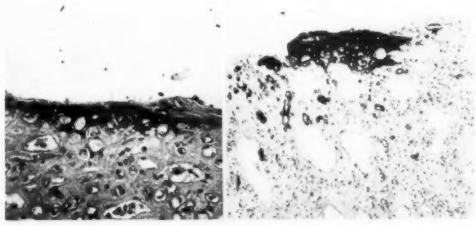

Fig. 6, left. Photomicrograph through a typical "milk patch" showing a plaque of calcium distinctly under the normal covering epithelium. Special staining methods have proved this to be calcium.

Fig. 7. Photomicrograph through specimen in lower left corner of Figure 5. Here the epithelium covering the calcium plaque has gone, and the plaque lies raw and bathed in calyceal urine. The wrinkled outer covering is of different character and coloring from the supporting plaque and appears to be a distinct secondary deposit. Note the early calcium deposits in the epithelial cells lining the uriniferous tubules in the deeper portion of the tissue, and the absence of any evidence of infection.

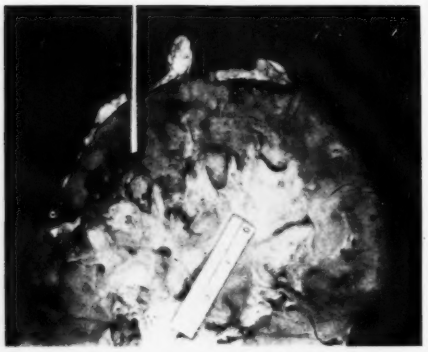

Fig. 8. Photograph of specimen showing a distinct crystalline calculus superimposed upon a typical "milk patch." This calculus is firmly adherent, but certainly not under the epithelial lining membrane as seen in the calculus plaques ("milk patches") on the other two papillæ that are exposed.

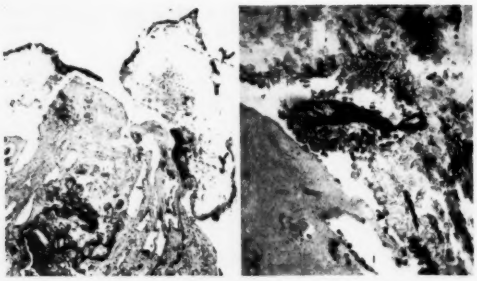

Fig. 9, left. Photomicrograph through the calculus seen on the papilla in Figure 8. The calcium plaque is indicated by *Y* and the calculus by *X*. Note the loose attachment of the plaque. By differentiating stains the calculus has been proved to be calcium phosphate and the plaque a different salt of calcium.

Fig. 10. Photomicrograph through the same specimen as in Figure 9, but near the periphery of the stone and plaque. It shows the calcium plaque almost free of attachment to the papilla, and its edge lifted upward by the intrusion of crystalline deposition. This microscopic evidence shows the mode of ultimate detachment of a calculus, from the papilla with its initiating lesion. (See also Figs. 3 and 4.)

though the material forming the "milk patch" had been deposited in circles. In all of the specimens of this character there is every evidence, with naked eye and hand lens, to suggest that what we have seen is under the surface of the covering epithelial cells. This interesting lesion, of course, was subjected to microscopic study. These sections have shown *a deposit of calcium, entirely devoid of any inflammatory evidences*, as being laid down in the wall of the renal papilla and in a position which is, in its earliest manifestation, entirely below the surface of the cells covering the papilla (Fig. 6). The renal papilla has neither serous nor mucous membrane covering, but the columnar epithelial cells which line the ducts are continued onto the surface of the papilla as a layer of flattened epithelium. This surface layer is generally but one or two cells deep. Under it the structures of the papilla are found—blood vessels, lymph spaces, supporting connective tissue, and tubules. The pathology of the lesion awaits the publication of a complete pathological opinion, but for the time being it seems fair to state that the area involved appears to suffer a definite fibrosis, with changes in the blood supply, and that the first deposit of calcium occurs in the cells lining the tubules, which, in turn, show different stages of aseptic necrosis. If one goes into the depth of the tissue, this process can be seen in its progressive stages, but as one approaches the surface, the deposit of calcium becomes more and more uniform and involves more of the interstitial tissue, until one reaches the surface, where it exists as a definite uniform plaque, bearing a similarity to calcium as deposited elsewhere in morbid processes in the body. Sections have been stained by special methods (von Kossa stain and Eros stain), and this deposit has been proved to be calcium.

The next, or second, stage in a stone's development is exemplified in a kidney removed from the body of a 46 year old male who died of left pyopneumothorax and cardiac failure. Each papilla in this kidney, with one normal papilla as an exception, showed the characteristic "milk patch" deposit; but on the surface of one such "milk patch" could be seen a tiny black dot (Fig. 5—lower left specimen). This dot is no larger than a grain of pepper, or a cinder in an eye, but it stands out in clear distinction to the other papillary lesions of the first variety. Serial sections cut through this tiny speck show that the calcium deposited in this area has lost its covering epithelium and exists as a raw, exposed surface of calcium, at whose periph-

Fig. 11. Black calculus growing as a cap on the papilla in the superior minor calyx. Calyceal wall opened and pinned back. The stone is of calcium oxalate. This postmortem finding is quite similar to the clinical case in Figure 1.

Fig. 12. Same as Figure 11, but stone has been removed and placed below its papilla with its opposed surface upward. On the papilla can be seen the lesion from which the stone took origin, and the cup-shaped surface of the stone shows its facet of mural attachment.

ery the epithelium dips down to an aseptic ulcer edge (Fig. 7). The black dot itself appears as a secondary covering layer, or deposit, which in the microscopic sections appears uniform and of a brown color. Again, no evidence of infection is present. The secondary surface deposit, which appears black in the gross specimen, and brown in the microscopic slide, is certainly of different composition from the calcium plaque that supports it. To date it is our earliest evidence of a primary renal calculus.

The next, or third, stage in the development of a stone was found in a kidney from the body of a 56 year old female who died of a malignant ovarian tumor and general carcinomatosis. This showed two papillæ with the characteristic "milk patches" thereon and a third papilla with a definite crystal deposit on a similar "milk patch," but in this case the crystal deposit measured approximately 2 millimeters in diameter (Fig. 8). It was densely adherent to the underlying tissue and, when sectioned, presented a characteristic papillary calcium plaque, and intimately adherent thereto, and growing therefrom, was the large crystalline calculus (Fig. 9). The sections from this specimen have been subjected to special staining methods; by von Kossa stain the calculus has been proved to be calcium phosphate, and by Eros stain the plaque again has been proved to be calcium, but not calcium phosphate. Let it here be noted that on this calcium plaque a secondary deposit of a definitely different chemical

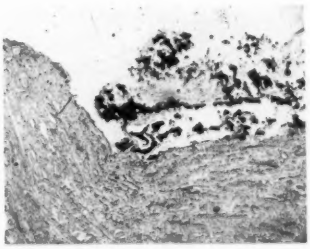

Fig. 13. Photomicrograph of papillary lesions shown in Figure 12. Note complete absence of any evidence of infection, the torn-out area from papilla and the soft sand-like deposit of calcium phosphate. The stone is calcium oxalate.

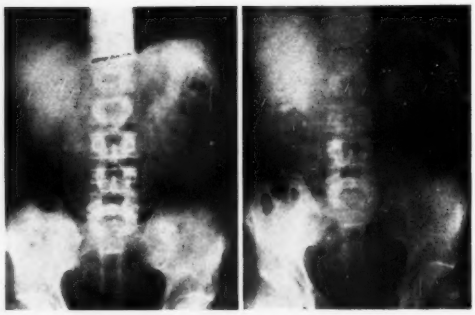

Fig. 14. Scout plate and urogram. The calculus at the ureteropelvic junction is easily seen. Just lateral to it and just beyond pointer can be seen a tiny shadow of a second stone, which urogram proves to be in the lowermost minor calyx.

Fig. 15. Calculus nested in minor calyx and opposed to superficial lesion on the renal papilla. Specimen obtained on resection of lower pole of kidney shown in Figure 14. *X* marks the sectioned papilla. The white material below the stone is part of the calyceal wall. Stone measures 4 millimeters in greatest diameter.

character has been formed. Another interesting and instructive observation is seen in a few of the sections cut near the stone's periphery, which show a definite undermining of the edge of the calcium plaque by crystalline deposits and growth of stone (Fig. 10). This strongly suggests that as the stone grows, it gradually encases the calcium plaque by undermining its edges, and when the stone breaks free, the plaque is torn from its papillary bed and goes away with the calculus. In this same kidney a similar concretion was found, which, unfortunately, the knife had already broken from its point of attachment. It is of interest that this was probably twice as large as the concretion described and, on being subjected to a chemical analysis, was likewise found to be composed of calcium phosphate.

A fourth specimen has given us a still further picture in the origin and development of renal calculi. This was found in the body of a man 60 years of age, seriously injured in an automobile accident, and who died of septicemia shortly after hospital admission. The superior calyx in this kidney intimately encased a typical black mulberry calculus, studded with tiny yellow dots (Fig. 11). It was triangular in shape and measured 7 by 6 by 6 millimeters. When its encasing calyceal wall was turned back, it was found to be plastered against the side of its papilla, and the calyceal wall itself was devoid of any evidence of ulceration or infection. Photographed *in situ*, it was then removed, and the portion of the calculus which had been in contact with the papilla was markedly cup-shaped, and the surface of the papilla against which it rested showed an area of soft, sand-like material of a clear yellow color, raised from the surface and measuring 3 by 5 millimeters (Fig. 12). Sections through this area of this papilla have shown that there is no calcium plaque present, but an eroded surface covered with sand-like particles which take the characteristic von Kossa stain for calcium phosphate (Fig. 13). There is no evidence of infection in the microscopic slides of this area. This stone was not adherent and, in fact, floated off its base when being photographed under water. The stone on analysis was calcium oxalate.

At about this stage in the research a patient presented himself with the typical clinical picture of acute right-sided ureteral calculus colic. The roentgen-ray demonstrated a stone in the ureter blocking it and located about 5 centimeters from the ureteropelvic junction. On this roentgen-ray plate could likewise be recognized the shadow of a smaller stone, measuring 5 by 6 millimeters in size, and unquestionably located in the cup of the minor calyx, at the inferior pole of the kidney

(Fig. 14). This man was operated upon and the stone in the upper ureter was removed by a simple ureterolithotomy. It was of a chalky white composition, irregular in outline, and, on analysis, was found to be composed for the major part of calcium oxalate. A forcep was introduced into the ureterotomy in an effort to reach the second calculus in the lower calyx, but as it could not be accomplished, the lower pole of the kidney was excised. The incision passed down through the cortex of the kidney and cut across the lower pole just proximal to the stone in the lower minor calyx mentioned. This specimen, when the calyx was opened, showed a stone of a character similar to the other one, measuring but 3 by 4 millimeters, lying to the outer side of its individual papilla and adherent thereto (Fig. 15). A pressure necrosis was present at the papillary-calyceal angle, which was considered to be secondary to the stone's growth. In handling this specimen, the stone was easily dislodged and fitted again into its place as perfectly as a dental inlay in a tooth. The side of the papilla showed a reddened excavation, or ulcer. Microscopic sections through this point showed no infection. There was considerable engorgement of the blood vessels, and there was every evidence that the original plaque had been torn loose or lifted from its bed with the dislodgement of the stone (Fig. 16). This stone, on analysis, has proved to be of the same composition as the one removed from the ureter—calcium oxalate.

It is my thought that as the secondary deposit, or true calculus, grows, crystallization at the edges of the original plaque gradually undermine the plaque and that the calculus, when it gains its freedom, does so by tearing out the plaque from the wall of the papilla. This appears quite definite in the microscopic sections of the last reported case, while, as already mentioned, some of our serial sections through the stone described as the third stage of calculus formation (the calcium phosphate stone above), distinctly show such undermining crystallization. As mentioned, numerous small calculi that have been obtained from patients after apparent, brief clinical existence consistently show just such a depressed area of what must have been the

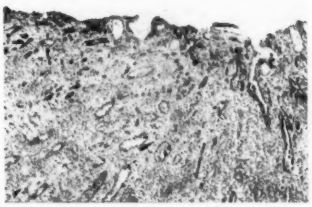

Fig. 16. Photomicrograph through papillary ulceration under stone shown in Figure 15. Only about one-half of the ulceration is in this picture, but it shows no evidence of infection, and every evidence of tearing away of the probably underlying calcium plaque.

point of attachment to the initiating lesion, and constitute one of the strongest leads which clinical evidence has given us in the suggestion of such an initiating lesion. These calculi are being particularly studied with this point in view.

## CONCLUSIONS

1. It has long been quite self-evident, from a careful analysis of our knowledge, both theoretical, investigative, and clinical, that stone of the kidney must be but a symptom of some underlying and supporting renal pathology.

2. With this preliminary report, I feel that the first postulate has been fulfilled in proving that renal stone originates by growth on an initiating lesion.

3. The second postulate, that such an initiating lesion must be sought for on a renal papilla, I feel has likewise been proved in the microscopic work performed upon the findings above related, for we have been fortunate, in the material available, in finding rather typical progressive steps in the growth of a calculus.

4. There has been described a pathological process occurring in the wall of the renal papilla, which, hitherto, has not been recognized, and which consists of a subsurface deposit of calcium.

5. In the series of cases presented we feel that, so far, we have traced from this subsurface deposit of calcium the destruction of its covering surface membrane and the deposit thereon of two characteristic types of

urinary salts—calcium phosphate and calcium oxalate. These salts appear to be direct secondary deposits upon this calcium plaque once it is denuded of its epithelial covering.

6. It is our belief that once such a calcium plaque has lost its covering membrane and from then on is bathed in the urinary excretion, on this calcium plaque, as a foreign body, there become deposited certain salts normally present in the urine, and that the salt so deposited follows closely the well recognized laws of the crystallization of salts from any solution wherein seeding for crystallization and supersaturation play the dominant rôles and the determining factors as to the character of salt to be deposited.

7. We do not presume that the above described pathological stages constitute the sole initiating lesion on which all stones originate, but reserve for further studies the possible relationship of focal infection, ulceration (both septic and aseptic), infarction, allergic mucous membrane reactions, the keratinization of avitaminosis, etc.

# CLINICAL SURGERY

*FROM THE DEPARTMENT OF THORACIC SURGERY, LAHEY CLINIC*

## SURGICAL TREATMENT OF CARCINOMA OF THE LUNG

### Technique of Lobectomy and Pneumonectomy

RICHARD H. OVERHOLT, M.D., F.A.C.S., Boston, Massachusetts

IN DESIGNING a surgical procedure which has as its purpose the cure of primary carcinoma of the lung, the surgeon is obliged to consider either a lobectomy or a pneumonectomy. Fortunately, the many aids (x-ray, pneumothorax, bronchoscopy, thoracoscopy) which have established the diagnosis for him have also told him the approximate location and extent of the growth.

A peripheral lesion involving one lobe or a carcinoma arising well out in a bronchus of one lobe may be successfully cured by a single lobe resection. The majority of primary lung tumors (80 per cent of our cases) have arisen in either the right or left main stem bronchus at the point of its division into the secondary bronchi. In order to remove a growth which is so centrally located in the bronchial tree, it is necessary to excise the entire lung and hilum, as well as the adjacent mediastinal glands.

Many of the technical problems which are confronted in the performance of lobectomy and pneumonectomy are quite different from those dealt with in general surgical procedures. Adequate thoracic exposure, the mobilization and handling of the lung, the treatment of the pulmonary vessels, and ligation of the bronchus are all matters of the greatest technical concern. The closure of the thoracic cage, the question of drainage, and space obliteration are other considerations peculiar to surgery of cancer of the lung.

The combined clinical experience of thoracic surgeons which has been rapidly accumulating during the past few years in performing lobectomy for bronchiectasis has helped greatly in the application of such an operation for malignancy. The one stage operation for bronchiectasis as carried out by Brunn, Shenstone and Janes, Edwards, and others can be used when the lesion is confined to one lobe and has not taken origin near the main bronchus.

In the technique of lobectomy for bronchiectasis, all surgeons have advised mass ligation with or without the use of a tourniquet, then separate ligation and individual treatment of the bronchus. This treatment of the pedicle in lobectomy has been adopted because of the technical difficulty in dissecting the branches of the pulmonary vessels at the root of the lobe. Since the infolding of the fissure does not always extend completely to the hilum, it is impossible to dissect out the vessels and bronchus without traversing the lung parenchyma. If such be done the amount of soiling of the field of operation is greatly increased and can hardly be avoided. However, if pneumonectomy is to be performed, it may be desirable, as Rienhoff, Archibald, and the author have done, to treat all of the structures of the hilum separately, remove mediastinal glands, and ligate the bronchus as near the carina as possible. There are, then, two distinctly different types of operative procedure to be considered in the performance of pneumonectomy.

In view of the fact that the majority of primary lung carcinomas arise in the major bronchi, the operation which makes possible the isolation and high division of the bronchus will be the one most commonly employed. Therefore, the technique of this operation, as used by the author, will be taken up first.

#### PNEUMONECTOMY BY SEPARATE LIGATION OF STRUCTURES OF HILUM

*Advantages.* The advantages of the dissection of the hilum are that (1) the main bronchus can be divided closer to the carina; (2) the mediastinal glands can be removed; (3) there is less danger of hemorrhage from the great vessels; (4) the lung itself does not have to be completely mobilized before the hilum is divided; hence the danger of expressing infectious material into the contralateral lung is greatly reduced as is also the likelihood of air embolism.

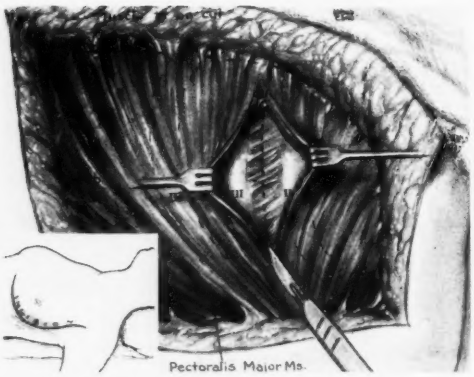


Fig. 1. Drawing showing location of incision and exposure of anterior thoracic cage. The breast is retracted upward and medially. The pectoral muscles are separated in the direction of their fibers over the third rib. The intercostal incision is made in the second interspace. The cartilages are divided at a point lateral to the internal mammary artery. A large, thick skin flap is provided which is not superimposed over the transcostal or intercostal incisions.

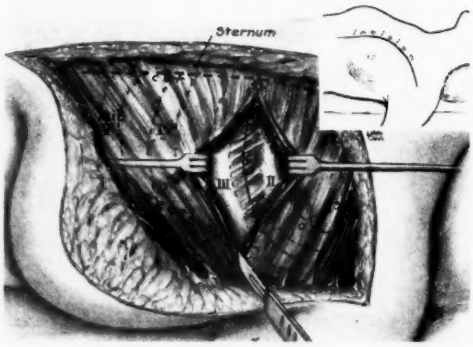


Fig. 2. Drawing of an anterior exposure useful in female subjects if the breast is large. The breast is retracted downward and laterally. The same exposure of the thoracic cage is provided.

*Exposure.* The use of an anterior thoracic incision has certain advantages when the separate isolation of the structures of the hilum is to be carried out: (1) The anterior approach is the shortest and provides most direct exposure of the mediastinum. (2) The question of operability can be settled without the necessity of mobilizing the lung. (3) The structures of the hilum are more accessible.[1]

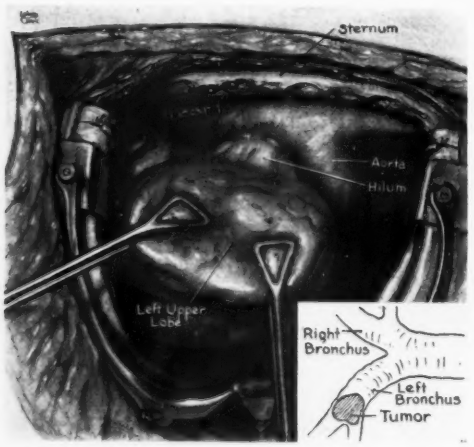


Fig. 3. The anterior approach to the hilum. The upper pulmonary lobe is retracted laterally and adhesions are divided. The hilum and mediastinum can be visualized and palpated.

*Technique.* The patient is placed on the back with a small pillow beneath the chest. The arm is permitted to drop over the edge of the table with the wrist fixed to the table just below the hip. The arm is then out of the way of the operator and anesthetist, and the pectoral muscles are relaxed.

The skin incision curves from the lower end of the sternum below and then lateral to the breast to end in the anterior axillary line near the clavicle. The breast is retracted upward and medially (Fig. 1). This provides a large skin flap to cover over the transcostal and intercostal incisions at the time of closure. In female subjects with large breasts we have at times preferred a medial incision. The breast is then retracted inferiorly and laterally (Fig. 2). Should an infection occur in a midline skin wound there is a greater likelihood of a spread down to the divided cartilages. The management of an infected midline incision is difficult. The incision as shown in Figure 1 is therefore used whenever possible. The attachments of the pectoral muscles are divided parasternally and the fibers of the same muscles split over the second interspace (Figs. 1 and 2). The cartilages of the first, second, third, fourth, and fifth ribs are then divided about 2 centimeters from the sternal border (lateral to the internal

[1]The difference in the accessibility of the hilum by way of the anterior and posterolateral approach is not a great one. During the past year a number of explorations and three pneumonectomies have been carried out through a high posterolateral incision. A surprisingly good exposure of the hilum for individual ligation of the structures was obtained. The posterior incision has the advantage of permitting one to approach the hilum from two directions, either from the front or from behind.

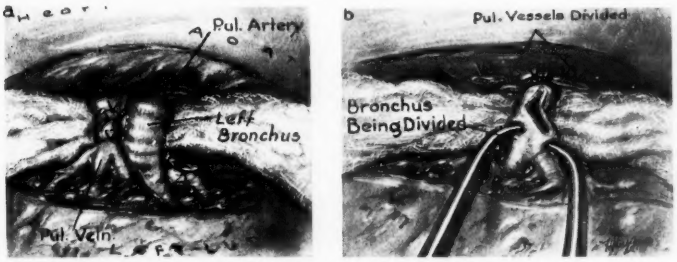


Fig. 4. Detail drawing of the structures of the left hilum. The mediastinal pleura has been separated. a, The pulmonary artery has been ligated and divided. Ligatures have been placed on the pulmonary vein. b, All vessels have been ligated. Ligatures have been placed on the bronchus medial to the growth. The drawing shows the bronchus partially severed.

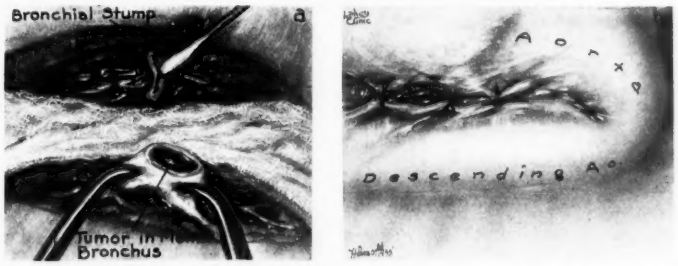


Fig. 5. Detail drawing of the structures of the hilum after their division. The medial end of the bronchus is carbolized. All lymphatic glands found in this area are removed. The severed vessels and bronchus are permitted to retract into the mediastinum. The mediastinal pleura is used to close this area.

mammary artery). The intercostal incision is made in the second interspace. A self-retaining retractor is placed in position (Fig. 3). In order to prevent the blades of the retractor from slipping along the rib margin, a piece of rubber tubing is fastened to the rib by an encircling silk suture, acting thus as a snubber.

Careful inspection and palpation of the mediastinum is then carried out to determine the extent of the infiltration of the growth, fixation of the mediastinum, and the presence of enlarged glands. The hilum itself is palpated between the thumb and forefinger to determine the location of the intrabronchial tumor.

Lung forceps are applied to the upper lobe and the lung gently retracted laterally. The mediastinal pleura above the hilum is incised and wiped down with dry gauze held in long artery forceps. The pulmonary artery is then isolated, 2 ligatures placed around it as far medially as possible, a third ligature is placed as far peripherally as possible and the vessel is cut between (Fig. 4). The 2 pulmonary veins are treated in a similar manner. The posterior mediastinal pleura can then be divided leaving the lung attached solely by the bronchus.

Traction on the lung is made and as much as possible of the mediastinal portion of the bronchus is pulled out into view. The bronchus is crushed with a clamp medial to the growth and at this point on the bronchus 2 silk ligatures are tied firmly down. A long, curved hemostat is applied to the bronchus peripheral to the ligatures to prevent an escape of material from its lumen. Gauze is packed around the area as a further protection against soiling. An incision is made half way through the bronchus between the ligatures and clamp and medial to the growth. The interior of the bronchus is carbolized (Fig. 4). The division of the bronchus is completed, the lung lifted from the thoracic cavity and the medial end of the bronchial stump again carbolized. Interrupted silk sutures are placed in the end of the cut bronchus. Extreme care should be used in the details of the treatment of the bronchus in regard to soiling. If the pleural cavity remains

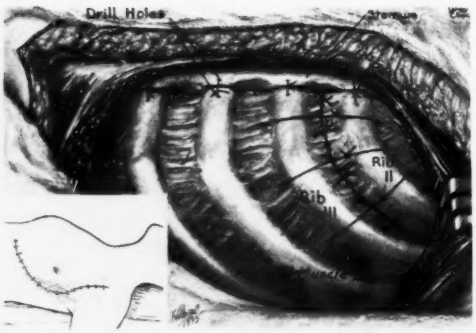


Fig. 6. Closure of the anterior incision. The ribs are returned to their normal position. A rigid thoracic wall in this area is maintained by not resecting any rib segments in providing the exposure. Suture of the pectoral muscles aids in sealing the transcartilaginous portion of the incision.

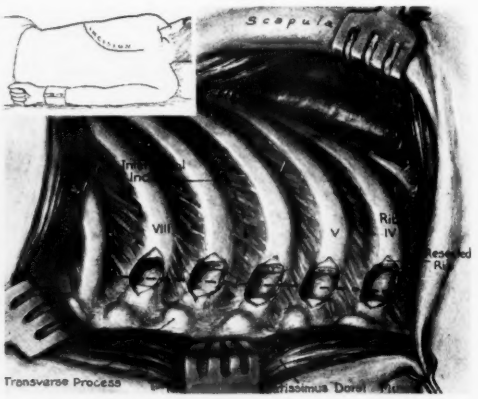


Fig. 7. The posterolateral approach to the thoracic cavity. The insert shows the position of the patient on the table and the location of the incision. Short segments of 4 or 5 ribs are resected between the posterior angle of the ribs and the transverse processes. The drawing shows the muscles divided, the scapula lifted, and the longissimus dorsi muscle retracted medially. The intercostal incision is made in the fourth or fifth interspace for pneumonectomy, in the seventh or eighth interspace for lower lobe lobectomy.

sterile, drainage later can be avoided and the necessity of subsequent thoracoplasty eliminated.

Any remaining lymph glands not already removed with the lung and hilum are removed from the mediastinum. The edges of the mediastinal pleura are then pulled over the ligated vessels and bronchus with interrupted sutures as completely as possible (Fig. 5). This buries the bronchial stump in the mediastinum. The surrounding tissues thicken to form an enclosure for the stump. By the time the end sloughs off and the silk sutures are free to be discharged, there is sufficient resistance around the bronchial stump to prevent leakage. The sutures themselves and the contents of a small abscess pocket which undoubtedly forms there are eventually coughed up.

Unless there has been obvious contamination of the pleura, the wound is closed without drainage. The best approximation of the ribs can be effected by drilling the ends and inserting sutures through the holes. The intercostal incision is closed by inserting sutures which encircle the second and third ribs. Small interrupted sutures are placed where necessary to make the closure air tight. The pectoral muscles are then sutured back in their normal position and the subcutaneous fascia and skin closed (Fig. 6).

### PNEUMONECTOMY AND LOBECTOMY BY MASS LIGATION

*Advantages.* The ligation of the lung root by mass ligatures has a place in the surgical treatment of carcinoma of the lung. Conditions which have led us to carry out mass ligation are as follows: (1) In single lobe or in combined middle and lower right lobe involvement. (2) In a peripheral growth, it may be the method of choice for pneumonectomy. (a) The presence of an inflammatory thickening in the region of the hilum renders the dissection of the structures difficult and relatively more hazardous than mass ligation. Dissemination of an infection in the mediastinal tissues must be considered. (b) The operating time is often a factor. Mass ligation can be carried out more readily than separate ligation. (c) Mass ligation should be resorted to when difficulties are encountered in attempting separate ligation and an abandonment of this method becomes necessary.

*Exposure.* A posterolateral incision provides the best exposure for the lower lobes and a lateral one for the right middle lobe. Such an incision has been used when: (1) The lesion is peripheral. A portion of the chest wall can be excised with the lung in the event that a direct extension of the growth has occurred. (2) The lesion is in the lower lobe and a lobectomy may suffice. (3) The condition of the patient demands a short operation. A posterolateral incision, which can be made more rapidly, is used in combination with the mass ligation technique.

*Technique.* The patient is placed upon the unaffected side in the horizontal lateral position. A pillow is used beneath the chest to arch the thoracic cage. The hips and shoulders are permitted to drop slightly forward, the body being fixed in

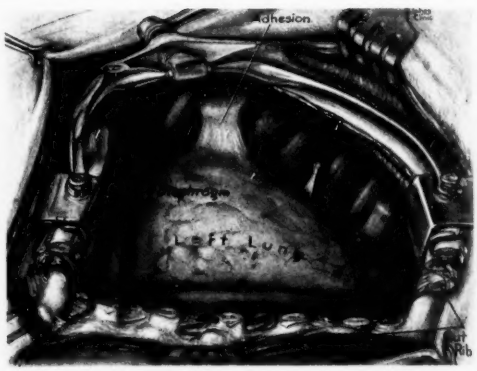


Fig. 8. Exposure of left hemithorax. Mobilization of the lung itself is the next step. Adequate space in which to work is essential.

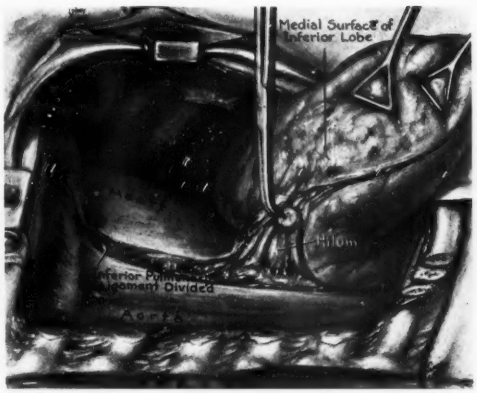


Fig. 9. Mobilization of lung. The inferior pulmonary ligament has been divided. Exposure of the inferior surface of the hilum has been made.

this position by a chest support placed anteriorly. The head of the table is then lowered 10 to 15 degrees.

The incision is begun at a point between the scapula and spine, is curved downward and forward around the tip of the scapula to the anterior axillary line over the fifth interspace (Fig. 7). The muscles are then divided and the thoracic cage exposed. The lateral attachments of the longissimus dorsi muscle are separated from the ribs and the muscle itself is retracted medially (Fig. 7). Inch segments of the fourth to the eighth ribs are resected from the transverse processes forward. The intercostal vessels and nerves are ligated and divided. The intercostal incision is made in the fourth interspace and carried forward to the anterior axillary line. A self-retaining retractor is then placed in position.

Pleural adhesions over the anterolateral aspect of the lung are divided (Fig. 8). The lung and mediastinum are palpated carefully to determine the extent of the lesion. If the hilum itself is not involved in an infiltrative process, the lung is more completely mobilized above, below, and posteriorly.

The inferior pulmonary ligament is freed from its attachment to the diaphragm and separated to the under surface of the veins of the hilum (Fig. 9). Oozing from this cut surface always occurs but it is best to accept it and proceed with the operation. It requires an unnecessary expenditure of time to clamp and ligate these small vessels with the lung still *in situ*. If hemostats are applied and left in place, they interfere with subsequent stages of the operation and their presence may do damage. The mediastinal pleura on all sides of the hilum is then picked up with forceps and divided with dissecting scissors. The hilum, itself, can be elongated slightly by wiping down the loose areolar tissue with gauze. A lung tourniquet (the author uses the Roberts-Nelson tourniquet) through which has been threaded heavy braided silk, is applied as far medially on the hilum as possible (Fig. 10). Two long right angle hemostats are then placed on the hilum to anchor the proximal tourniquet cord. Two additional hemostats are placed on the hilum distal to the first two. These prevent the second tourniquet from overriding the first (Fig. 10). In order to provide double security to the proximal tourniquet, 2 transfixion ligatures are inserted, the needle traversing the bronchus (Figs. 10, 11, and 12). A double silk thread is used in each suture. This makes it possible to tie each ligature both ways around the hilum (Fig. 11, a). In Figure 11, b is shown a drawing of the hilum ready for division. Considerable precaution should be taken in regard to the slipping of the proximal tourniquet. The hilum is a short structure. The thoracic cage and mediastinum are in constant motion. The handle of the tourniquet tends to pry the loop of the tourniquet loose from the cut hilum stump. The bronchus itself tends to retract medially leaving the tourniquet cord around the softer structures of the hilum. From reports, more than one patient has bled to death on the table by the structures slipping out of the proximal tourniquet. The application of transfixion sutures is a necessary safeguard and one of the most important steps in the operation. The

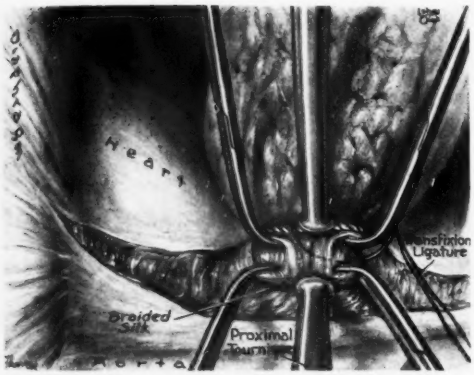


Fig. 10. Application of tourniquets. Braided silk is used in the proximal tourniquet. Note use of angled clamps to anchor the tourniquet cords. Transfixion ligatures are placed between the encircling tourniquet cords.

division of the hilum is carried out distal to the transfixion sutures and proximal to the distal tourniquet. After the bronchus is cut half way through, the lumen is carbolized, the resection completed, and the stump carbolized again (Fig. 12, a). Interrupted sutures (silk) are inserted in the cut bronchus and the ends of the pulmonary vessels are picked up with long curved artery forceps and ligated individually (Fig. 12, b).

Provided there has not been soiling of the pleural cavity and the lung root, the stump itself is buried (Fig. 13). The pleural attachments of the inferior pulmonary ligament are brought together and, if possible, the pleura is pulled over the stump.

If the entire lung has been removed and if there has not been contamination of the pleural space, drainage is not used. In all lobectomy cases and after pneumonectomy with soiling of the pleural cavity, closed tube drainage is provided. A trocar and cannula is inserted in the eighth interspace (below the incision) in the midaxillary line and a catheter is inserted before the thoracic wound itself is closed.

The first step in the closure is illustrated in Figure 14. The ribs are approximated and held in place with interrupted sutures. The previous resection of 1 inch of the posterior ends of the ribs prevents the cut rib ends from actually coming together. The longissimus dorsi muscle is then permitted to fall back into its normal position covering the rib ends and sealing the chest airtight (Fig. 15).

It is important in carrying out thoracic exploration and especially in pneumonectomy to return all ribs to their normal position. A resection of a number of ribs in order to provide an exposure will result in a partially flaccid chest wall after operation. The respiratory ability of the patient in the postoperative period is reduced by even small areas which undergo paradoxical movement. The integrity of the thoracic cage should be maintained, if possible.

### GENERAL CONSIDERATIONS

Many problems present themselves in the management of lobectomy and pneumonectomy cases which would not be included in a strict discussion of operative technique. These factors have as much to do with success in the treatment of carcinoma of the lung as the operation itself.

The induction of a preliminary pneumothorax on the involved side, if possible, is desirable from many points of view. (1) It provides information as regards the condition of the pleura, the presence of adhesions, and the relative position of the growth. (2) Respiratory changes and alterations in circulation are brought about gradually. (3) The ability of the contralateral lung is tested. Vital capacity and lung volume determinations are made after pneumothorax has been established. (4) The diseased lung is more completely emptied of secretions before the patient reaches the operating table.

Interruption of the phrenic nerve is not done as a preliminary procedure to lobectomy or pneumonectomy. Interference with the internal drainage of the involved lung is not to be desired during the period of preparation. For the same reason in patients after lobectomy a functioning diaphragm is important for its effect on the remaining lobe. During the operation cyclopropane anesthesia provides shallow respiratory excursions so that paralysis of the diaphragm is not indicated on the grounds of reducing motion in the operative field.

An intrapleural thoracoscopic examination has recently been done as a routine procedure when a pneumothorax has been successfully induced. The condition of the pleura, mediastinum, and hilum can be studied. If the tissues in the region of the hilum are fixed and if the vessels cannot be seen to pulsate, operability is questioned. Information regarding operability may be obtained.

Venous pressure readings have proved to be of value in the determination of mediastinal metastases. When a marked bilateral elevation of the venous pressure is found, involvement of the mediastinum is suspected. The value of venous pressure determinations in thoracic disease has been outlined by Pilcher and Overholt.

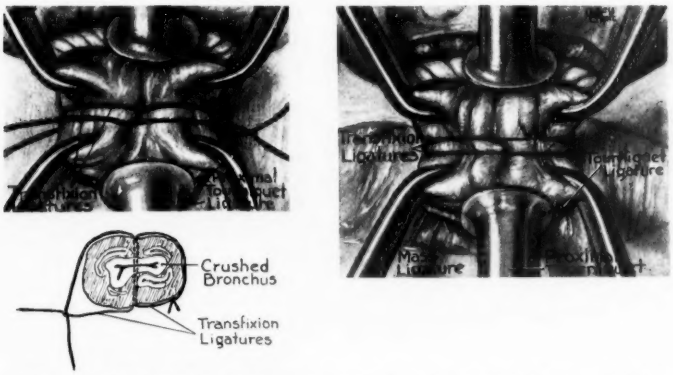


Fig. 11. a, Transfixion ligatures are inserted in the crushed hilum and tied in both directions. b, The hilum ready for division. The incision is made between the distal transfixion ligature and the distal tourniquet cord. Note the manner in which the angled clamps are applied to anchor the tourniquet cords. Every precaution is taken to prevent a retraction of the structures of the hilum out of the proximal tourniquet cord.

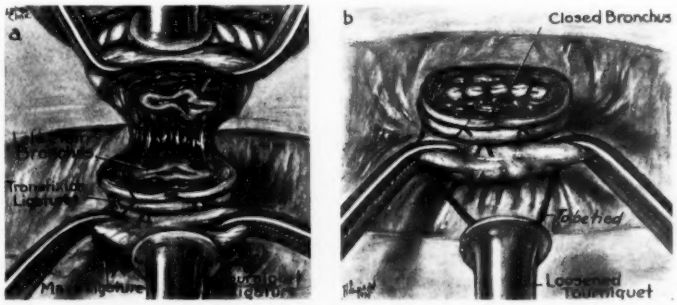


Fig. 12. a, Division of the hilum. As soon as the bronchus is opened its interior is swabbed with phenol. Note how securely the stump is held. b, Closure of the cut end of the bronchus and vessels with interrupted silk sutures. The tourniquet is then loosened, the braided silk tourniquet cord is not disengaged from the stump but is tied down and left as a mass ligature.

All thoracic explorations are carried out under cyclopropane intratracheal anesthesia. The intratracheal tube is inserted after a preliminary induction of cyclopropane by means of a mask or after the intravenous administration of evipal. Cyclopropane has proved to be the anesthetic of choice by virtue of the fact that surgical anesthesia can be produced with extremely low anesthetic gas percentages, between 10 and 20 per cent. This permits an administration of oxygen throughout the entire period of the operation of 80 to 90 per cent. Since there is always an adequate supply of oxygen, effects of anoxemia do not appear. The respiratory movements are greatly reduced, thereby facilitating the technical aspects of the operation. A report of anesthesia in thoracic surgery with special reference to cyclopropane has recently been made by Eversole and Overholt.

Oxygen therapy is used routinely during the early postoperative period. Concentrations of 40 to 50 per cent are used. After 4 or 5 days, the concentration is reduced and the tent applied only as indicated.

Postoperative intrapleural pressure readings in the pneumonectomized patient are made immediately at the conclusion of the operation and every 12 hours for 2 to 3 days, then as often as necessary, as indicated by bedside roentgenograms. Air is withdrawn or introduced into the

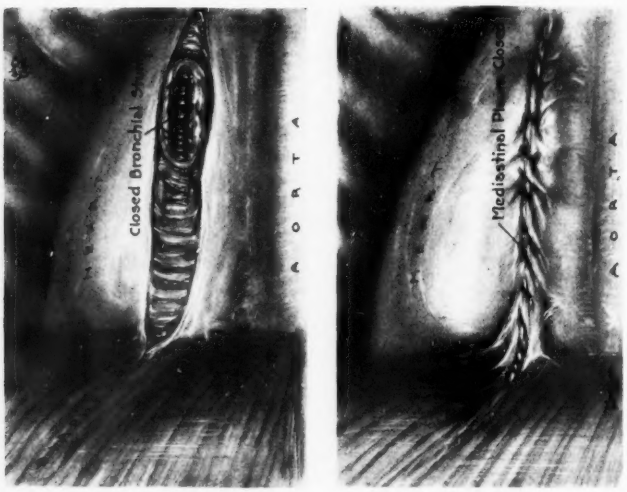


Fig. 13. Appearance of thoracic cavity after lung has been removed. The hilar stump is permitted to retract in the mediastinum. If the steps of the operation have been carried out without soiling, the stump is buried as well as it can be by the mediastinal pleura.

chest as necessary to maintain a negative pressure of minus 4 to minus 12 centimeters of water. When fluid appears, it is aspirated and replaced with air in order to maintain the same physiological pressures.

Fluid from the chest is cultured on various occasions and if a positive culture is obtained, closed tube drainage of the pleural space is instituted at once. Constant suction of minus 10 centimeters is provided and antiseptic irrigating solutions are used. All lobectomy patients, mentioned above, have tube drainage established at the time of operation. Constant suction is applied and after 4 to 8 days small amounts of irrigating solutions are used to keep the tube open.

*Necessity for thoracoplasty.* The obliteration of the pleural space following pneumonectomy has been the subject of much discussion. There is little question but that any form of thoracoplasty should not be attempted at the time of the lung removal. The patient needs an intact thoracic cage to use while he is recovering from the pneu-

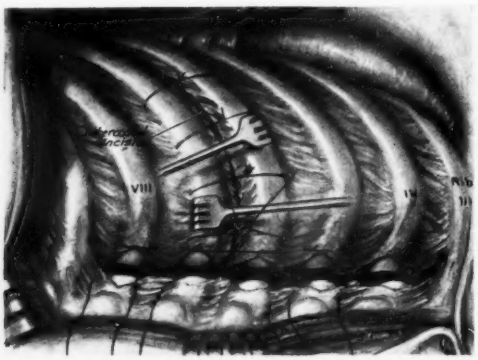


Fig. 14. Closure of the thoracic wall. Ribs are held in place with interrupted sutures.

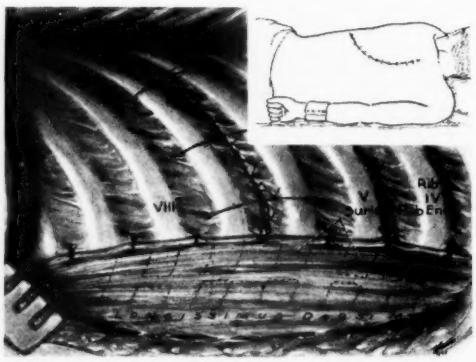


Fig. 15. Closure of the thoracic wound. Note the manner in which the longissimus dorsi muscle is used to cover the rib ends. An air tight closure can be made.

monectomy. The space itself calls for no immediate consideration because pressure within that space can be controlled. It has been the experience of Rienhoff (10 cases) and of the author (5 of 11 cases) that thoracoplasty can be indefinitely postponed provided infection of the space has not occurred. The pleura thickens greatly, the remaining cavity fills up with serum, fibrin forms, and coagulation of the fluid occurs. There is retraction of the thoracic cage and some displacement of the mediastinum. There is apparently little mechanical disturbance of the circulation. The ultimate dangers of enforced emphysema of the remaining lung in individuals of middle age or past have not been determined as yet. If, however, the space becomes infected, a graded thoracoplasty should be considered at a later date in order to close the chronic empyema cavity. The age of the patient, the likelihood of metastasis, the degree of the inconvenience of the draining thoracic sinus all must be considered before thoracoplasty is recommended.

The author has by the outlined methods performed lobectomy on 19 patients (2 carcinoma, 17 bronchiectasis) with 1 operative fatality and pneumonectomy on 11 patients (9 carcinoma, 2 suppuration) with 7 operative recoveries. Four pneumonectomized carcinoma patients are living, 38, 32, 7, and 4 months after operation. Individual case reports of the author's pneumonectomy cases were presented before the American Association for Thoracic Surgery in June, 1935 (9). A sufficient number of successful cases has been reported in the literature to give definite encouragement in the treatment of carcinoma in this location. The reader should refer to the discussions of Heuer, Alexander, and the reports of Graham and Singer, Rienhoff, Churchill, and others.

SUMMARY

1. Lobectomy and pneumonectomy are the two procedures which surgery has to offer in the treatment of carcinoma of the lung.

2. Pneumonectomy provides the best chance of cure and will be required in the majority of cases because of the relative frequency of the site of origin of the lesion in a stem bronchus.

3. Two methods of treating the lung root have been presented in detail and illustrated. Indications for the use of each have been outlined.

4. General considerations of the preoperative and postoperative management of the lobectomy and pneumonectomy case have been given.

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# CRUCIATE LIGAMENT INJURIES

## Caused by Complete and Incomplete Dislocations
## Early and Late Pathology, Symptoms, and a Method of Repair

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IN THIS paper we wish to present a résumé of our cases of complete and partial dislocations of the knee joint in which there have been ruptures of one or both cruciate ligaments (Table I).

TABLE I

| | Cases | Seen early | Seen late |
|---|---|---|---|
| Double cruciate ligament injuries..... | 10 | 6 | 4 |
| Anterior cruciate ligament injuries..... | 4 | 3 | 1 |
| Posterior cruciate ligament injuries..... | 2 | . | 2 |

We have had 9 patients with complete dislocations of the knee joint with a rupture of both cruciate ligaments. Five were seen soon after the injury was received and a diagnosis made. Four were seen late, from 3 to 8 months following the injury. In 2 of these patients the vessels in the popliteal space was destroyed. One patient had a compound dislocation with rupture of the collateral fibular ligament. One patient had a complete dislocation of both knee joints with none of the great vessels injured. The 4 patients who were seen late, from 3 to 8 months following the date of the injury, were operated by the methods to be detailed later.

We have had 4 patients with injuries to the anterior cruciate ligament. Three were seen soon after the injury was received; 1 was seen late. One had an avulsion of the anterior cruciate ligament from the condyle of the femur. The ligament was dislocated between the lateral condyles of the femur and the tibia. It simulated an injury to the lateral meniscus. One had a rupture of the middle portion of the anterior cruciate ligament with a fracture dislocation of the medial meniscus. One had a rupture through the middle portion of the anterior cruciate ligament and a transverse rupture of the collateral tibial ligament. The 1 patient seen late had a rupture of the anterior cruciate ligament in which the medial meniscus had been removed previously for fracture and dislocation.

We have had 2 patients with partial dislocations of the knee joint with injury to the posterior cruciate ligaments. Both were seen late. There was no injury to the vessels; no compounding.

Let us first consider the 5 patients who suffered a complete dislocation of the knee joint. With the one individual who had both knees dislocated included there is a total of 6 joints to be considered.

The patient with both knee joints dislocated was 5 feet 9 inches tall and weighed 346 pounds. He had also suffered multiple injuries in other locations. Attempts at immobilization and adequate care all were frustrated by his serious condition and great weight. He finally recovered sufficiently to hobble around and the left knee, which was strengthened by an overlapping of the collateral tibial ligament, has held up fairly well. The right knee, which he refused to have operated upon, is almost useless at this time, 7 years following the accident. At present this man is in the hospital again with diabetes and a swelling and edema of this right lower limb, and in addition a peculiar discoloration which suggests that there has been an injury to the vessels. These conditions will preclude any attempt at a correction of this knee joint for some time.

### SYMPTOMS AND PHYSICAL FINDINGS

*Symptoms and physical findings.* We have had 2 cases of complete unreduced dislocations of the knee joint. The limbs were shortened and recurved, with a total loss of the use of the limbs. The 2 cases observed had the tibial head dislocated backward into the popliteal space. They were reduced under complete ether anesthesia by slight flexion and pulling of the tibial head forward. After reduction, the tibial head could be carried in any direction around the femoral condyles and any type of dislocation could be reproduced.

We have had 3 patients with complete rupture of all the ligaments of the knee joint in whom the dislocation had been reduced by the continuation of the force. These we were able to observe immediately following the injury, in which all of the ligaments had been injured, and it was possible

From the Fracture Service of the Cook County Hospital.

to produce any type of dislocation that we desired—medial, lateral, anterior, or posterior. In fact, there was no difference clinically from the 2 that had to be reduced. There was a total loss of function, marked swelling, discoloration, and exquisite tenderness over the entire joint. One knee joint was compounded through the collateral fibular ligament. In 2 of these dislocated knee joints, the popliteal vessels had been injured. In these 2 the entire limb was wrapped in dry cotton, elevated in a floating Thomas splint, and kept under a cradle at an even temperature of 100 degrees. After 4 months a gangrenous toe was removed from one patient and in the other an amputation was made at the middle and upper third of the leg. But the most interesting observation is that both patients have good and serviceable knee joints.

Two other knee joints, 1 with a compound wound, were immobilized for 4 months in plaster casts. They made perfect recoveries. Therefore, of 6 completely dislocated knee joints we have 4 excellent recoveries, 1 fair, and 1, untreated, a failure.

These early cases of complete dislocation and the results obtained are related to emphasize the value of early and accurate diagnosis and the subsequent successful outcome following immobilization. But, above all, we wish to emphasize the fact that this diagnosis cannot be made roentgenographically. The diagnosis must be made by physical examination and the moving of the tibial condyles in every direction. If the limb is placed in a cast and the bones are in good alinement, roentgenographic diagnosis is impossible and the surgeon is uncertain as to how long the immobilization should be continued.

*Old dislocations of the knee joint diagnosed as ruptured cruciate ligaments of the knee.* We have had 4 such cases and they have come under our observation from 3 months to 8 months following the injury. The symptoms in these were:

1. Loss of stability or function, the limb breaking down anteriorly or wabbling in a lateral direction.
2. Pain or tenderness not marked.
3. Fluid, either a slight amount or negative.
4. No stiffness or limitation.
5. Marked passive mobility at all times and very extensive mobility when patient is put under anesthesia—almost 2½ inches of motion in the anteroposterior direction—and a lateral or medial deviation of the extended leg of 30 to 50 degrees.

Roentgenographic examination in these late cases shows thickening over the femoral condyles where the collateral ligaments have been detached from the bone. But this finding has only been present in the late cases and has not been present where a ligament has been ruptured. In neither the recent nor the old cases of complete dislocation have we observed the avulsion of the tibial spines, although there is 1 case which might be classed as doubtful. No detachment of the collateral tibial ligament from the tibial head has been observed. The fibular head was avulsed and the collateral fibular ligament ruptured obliquely in 2 cases, 1 recent and 1 old.

*Pathology.* The extreme looseness of the knee joint following a dislocation is caused by the following lesions:

1. Complete rupture of the cruciate ligaments.
2. Avulsion of the collateral tibial, collateral fibular, and the oblique popliteal ligament from their attachments, or the rupture of these ligaments in their continuity.

We have observed evidences of avulsion of the collateral tibial and collateral fibular ligaments from the femoral condyles. Two collateral fibular ligaments had been ruptured and the fibular head avulsed. We have had 1 iliotibial band split from the top of the tibia 8 inches up through the fascia lata.

*The end results in cases of ruptured cruciate ligaments.* We have observed no trace of the injured cruciate ligaments remaining in any of the injured joints operated upon 3 months or more after the injury has been sustained, either in the single or in the double type of cruciate ligament injury. Where the dislocation has been complete the joint cavity can be freely and rapidly inspected and in none of our old cases has a trace of these ligaments remained. The points of origin and attachment are smooth, covered with synovial membrane, and no free fragments have been present in the joint. Of the 2 old cases of posterior cruciate ligament rupture, no trace could be found on the lateral side of the medial condyle, but we could not observe the posterior attachment and therefore cannot express an opinion concerning the presence or absence of fragments of the ligament at that spot. In the 1 old anterior cruciate ligament injury we were sure that both the anterior and posterior areas of attachment revealed no trace of the injured ligament.

In none of the 4 cases of complete rupture of the cruciate ligaments were the menisci injured or displaced. In the 2 old injuries to the posterior cruciates both menisci were normal. There were no detached pieces of cartilage, bone, or ligament in the joint cavity of any old case. In only 1 case was there a lesion in the cartilage of the femoral condyles. This case will be discussed later.

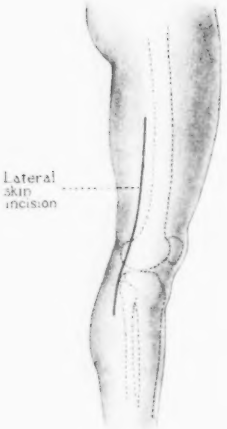


Fig. 1.

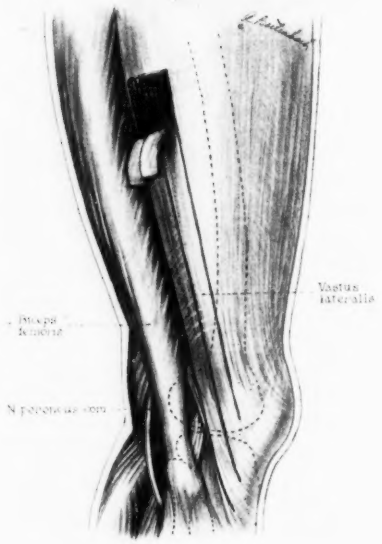


Fig. 2.

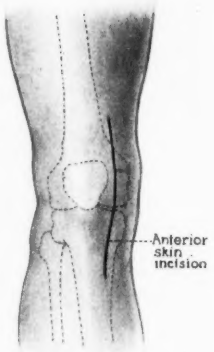


Fig. 3.

Fig. 1. The leg is made bloodless with a Martin band which ends as a tourniquet adjacent to the hip joint in the highest part of the thigh. The lateral skin incision extends from 11 inches above the joint down to 1½ inches below the head of the fibula. It is curved slightly forward.

Fig. 2. Strips of fascia lata are freed. They must be 1 inch wide and about 9 inches long. The anterior is elevated to the middle of the lateral femoral condyle. The posterior strip is elevated down to where it curves forward on the head of the tibia.

Fig. 3. The anterior incision should be about 8 inches long. It extends down through the vastus intermedialis muscle and the capsule of the knee joint and down 3½ inches on to the head of the tibia. It will save time if the osteoperiosteal beds for the new ligaments are prepared when this incision is made.

The ability of the knee joint to stabilize itself if immobilized is remarkable and is due to the reattachment of avulsed ligaments and the healing of those that are torn. Of course, we cannot be certain that these cruciates have regenerated and only an exploratory operation or a postmortem examination could prove what has happened to these cruciates in knee joints that have seemingly made a perfect recovery. Why a knee joint that is fixed early and for a long period should apparently permit a healing of the injuries of all ligaments and a joint that is not stabilized or immobilized should result in a healing of the collateral ligaments and an absorption of the cruciates we cannot explain. It certainly will be food for thought, observation, and experimentation.

*Posterior cruciate ligament injuries.* Two patients with old injuries to the posterior cruciate ligaments were seen 4 to 6 months, respectively, following the accidents. The loss of this ligament causes great disability, the femur being permitted to slip forward on the tibial head in such a manner that an imbalance is produced and the patient staggers if not supported.

The physical findings in our 2 cases were simple. The tibial head, when flexed upon the femur, can be pushed back from an inch to an inch and a quarter without a general anesthesia and 2 inches with complete anesthesia. About 10 degrees of lateral mobility was present with the legs extended on the thigh. There was a slight excess of fluid, but no tenderness.

One old anterior cruciate ligament case was seen 8 years following the removal of the medial meniscus. The symptoms were a slight instability and very little, if any, excess in mobility in the anteroposterior direction and no lateral mobility with the leg extended on the thigh. But the joint would lock when the man was asleep and, to describe it in his own words, when freed would "crack like a pistol shot." When anesthetized and the great thigh muscles of this individual were relaxed, the tibial condyles could be pulled forward 1½ inches. The locking was shown at the operation to have been caused by the spine of

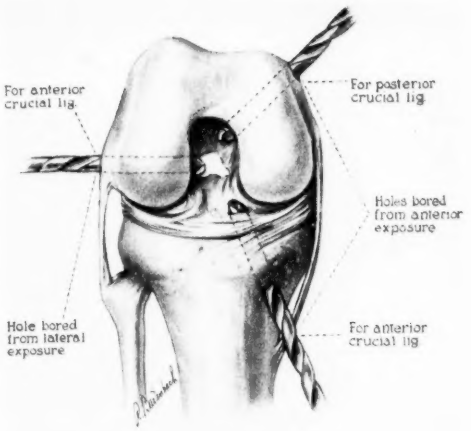
For anterior crucial lig.
For posterior crucial lig.
Holes bored from anterior exposure
Hole bored from lateral exposure
For anterior crucial lig.

Fig. 4. Shows the drill holes made for insertions of the new ligaments. The first drill hole is made horizontally through the posterior portion of the lateral condyle of the femur. The second drill hole is made as indicated diagonally down through the medial condyle. The third drill hole is made obliquely up through the head of the tibia, emerging just posterior to the transverse ligament. Drill measurements should be $\frac{13}{32}$ inches in diameter.

the tibia being fixed into the cartilage of the lateral condyle of the femur. The lesion was plainly evident.

Three cases of recent injuries to the anterior cruciate ligament were seen and operated upon early, 2 under a mistaken diagnosis, and the third with the diagnosis of an anterior cruciate ligament injury and a transverse tear of the collateral tibial ligament. The first case simulated a ruptured lateral meniscus. The man gave a history of an injury with subsequent catching and locking with a large quantity of fluid in the joint. The pain and tenderness were on the outer side of the knee joint. When the knee joint was opened it was found that the anterior cruciate ligament had been detached from its origin on the medial surface of the lateral condyle and displaced downward and laterally beneath the lateral condyles of the tibia and femur. This detached end of the ligament was caught up, fixed with heavy silk, a hole bored in the posterior portion of the lateral condyle, the silk drawn through, the ligament fixed in its normal position, the limb immobilized and flexed in an angle of 25 degrees for about 1 month, and then the leg extended in a straight angle and immobilization continued for an additional 3 months. A perfect recovery was obtained. The meniscus had not been injured.

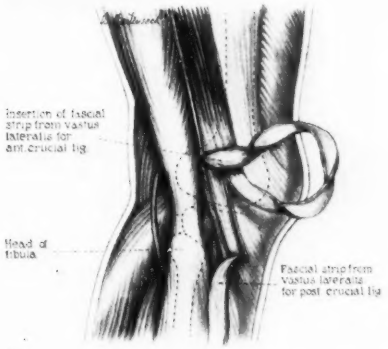
Insertion of fascial strip from Vastus lateralis for ant. crucial lig.
Head of fibula
Fascial strip from Vastus lateralis for post. crucial lig.

Fig. 5. Shows the point of insertion of the new anterior cruciate ligament and the spot to which the new posterior cruciate ligament is dissected down to the head of the tibia. The new ligaments should be twisted slightly.

The second case was also diagnosed as a meniscal injury. In this we suspected that the medial meniscus had been fractured and dislocated. When the knee joint was opened it was found that the meniscus had been fractured and that there was also a rupture through the middle portion of the anterior cruciate ligament. These ends were united with catgut and the knee joint im-

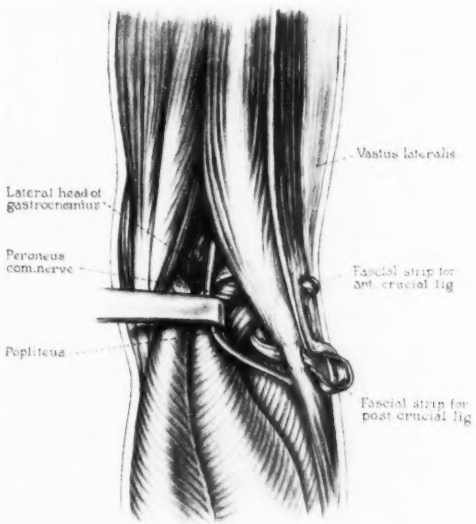


Fig. 6. The posterior cruciate ligament being drawn in through the fascia over the head of the fibula beneath the lateral belly of the gastrocnemius, the peroneal nerve and the popliteus tendon.

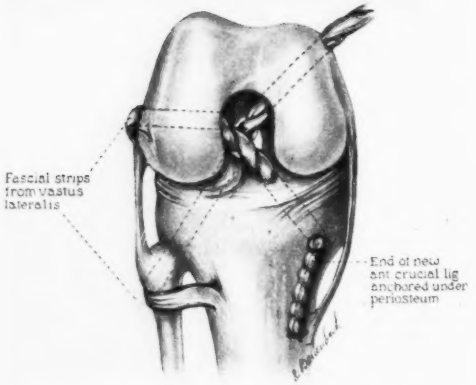


Fig. 7. Shows the ligaments pulled into position through the new openings and the anterior sutured into position with a continuous catgut stitch.

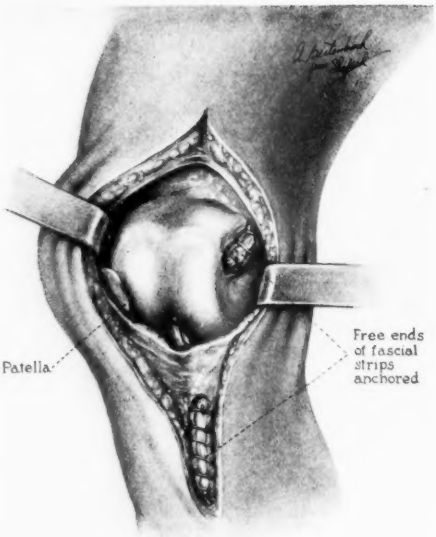


Fig. 8. Shows both ligaments sutured into position.

mobilized and flexed at an angle of 25 degrees for about 1 month; then the leg was extended in a straight angle and immobilization continued for an additional 3 months. The recovery was perfect.

The third case was easy to diagnose. There was a definite rupture of the collateral tibial ligament about 3 inches long. This was transverse and the fingers could push the skin through the lesion in this ligament. In addition to this it was possible to displace the tibial head far forward when the limb was flexed. There was also a marked lateral instability. The extended leg could be carried to a valgus position of about 40 degrees with the thigh. At the time of operation we remade the anterior cruciate ligament, using the method of Hey-Groves and Alwyn Smith, and sutured the transverse lesion of the collateral tibial ligament with No. 00 chromicized catgut. The immobilization was continued at an angle of 25 degrees for 1 month; then the leg was extended in a straight angle and the immobilization continued for an additional 3 months. The result was perfect.

The anterior cruciate ligament was repaired by the same method. However, at the end of 8 weeks this man danced on his limb and though it is not in good condition, it is slowly becoming a more stable joint.

Three double cruciate ligament operations have been done by the method published in SURGERY, GYNECOLOGY AND OBSTETRICS, February 15, 1932. Two of these joints are perfect. One of them is good, but this man is on relief and will not work. It is well to state here, however, that this individual also had a rupture of the collateral tibial ligament with an avulsion of the fibular head and, in spite of 2 attempts at suturing and strengthening this collateral fibular ligament, we have not succeeded in making it as strong as we would wish. The fact that this one double cruciate ligament operation was not satisfactory and that the patient had a certain amount of atrophy of his biceps femoris muscle caused us to seek for a different procedure which would obviate the use of the aponeurosis of the biceps femoris.

### METHOD OF OPERATIVE PROCEDURE

In this new method we make the limb bloodless with a Martin band and a tourniquet on the upper portion of the thigh. An incision 13 inches long, as illustrated in Figure 1, is used. It extends from 10 inches up the thigh down and around the head of the fibula; then a strip of fascia lata 1 inch wide is removed and dissected down to where it has a loose attachment on the lateral condyle of the femur. Another strip posterior to it and about the same width is then dissected from its base down to where it curves forward and is attached to the head of the tibia (Fig. 2). The knee joint itself is then opened (Fig. 3). The incision extends down through the skin, through the lateral portion of the vastus medialis, through

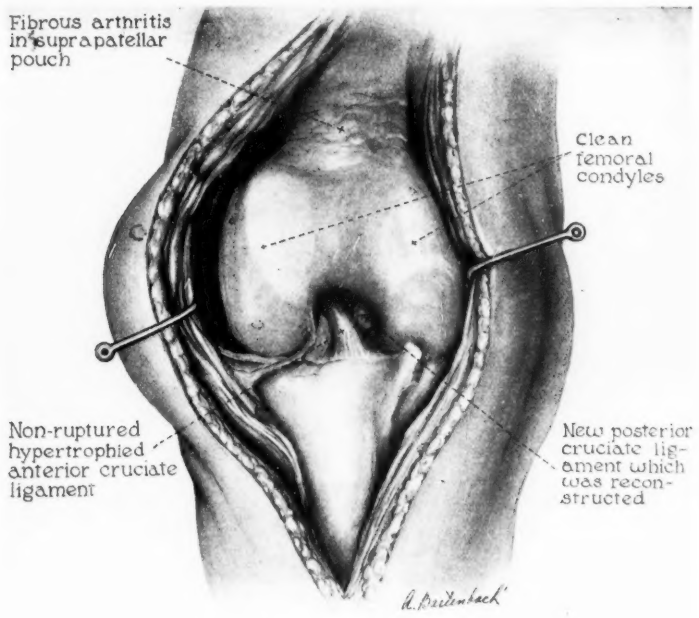
Fibrous arthritis in supra patellar pouch
Clean femoral condyles
Non-ruptured hypertrophied anterior cruciate ligament
New posterior cruciate ligament which was reconstructed

Fig. 9. Postmortem specimen of a reconstructed posterior cruciate ligament obtained 10 months following operation. Position shown. Joint firm. Operation a success.

the fascia and synovia of the knee joint, until the suprapatellar space is exposed, then down upon the head of the tibia for a distance of 3 inches. As this incision is made it can be carried in through the synovial membrane and periosteum of the femur above the condyle about 2½ inches, and the periosteum and synovia elevated to a width of about ¾ inches. On the head of the tibia a like incision is made down through the periosteum and the periosteum dissected up about ¾ inches.

The holes may now be drilled in these condyles for the placement of the new ligaments. This is shown in Figure 4. A drill $\frac{13}{32}$ inches in diameter is used. It is inserted into the lower portion of the osteoperiosteal bed which was prepared on the anterior surface of the femur and driven obliquely downward and forward through this condyle, as shown in Figure 4. It is then put through the spot where the osteoperiosteal bed was prepared in the head of the tibia, driven upward and forward, to emerge just posterior to the transverse ligament of the knee joint. A similar opening is then drilled horizontally through the posterior portion of the lateral condyle. The new ligaments are twisted slightly as shown in Figure 5. Curved alligator forceps can now be passed outward through this lateral condyle to grasp the new ligament and pull it through into the knee joint. The new posterior ligament is then carried through the fascia, covering the head of the fibula so that it will have a firm point of fixation, and pushed up beneath the lateral head of the gastrocnemius, the peroneal nerve, and the popliteus tendon, through the posterior capsule into the knee joint. It is grasped with forceps as it comes through into the joint, pulled forward and, with alligator forceps, pulled up through the medial condyle of the femur. The new anterior cruciate is now pulled down through the head of the tibia, the ligaments are drawn so that they are firm, but not tight, with the limb flexed at an angle of approximately 25 to 35 degrees, and then they are sutured into their osteoperiosteal beds, as shown in Figures 7 and 8.

The wound in the lateral surface of the thigh and leg is now closed with clips. No effort is made to close the fascia. It will regenerate in a fairly perfect manner if it is not interfered with by an attempt at closure.

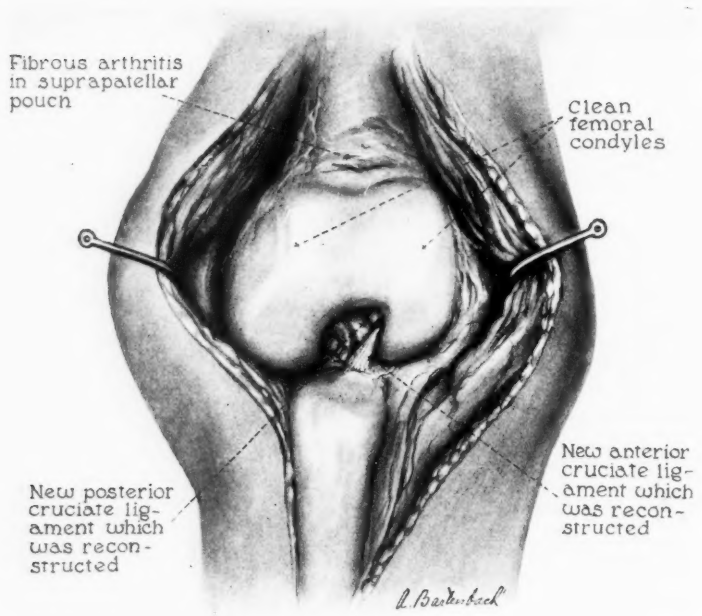
Fibrous arthritis in suprapatellar pouch
Clean femoral condyles
New anterior cruciate ligament which was reconstructed
New posterior cruciate ligament which was reconstructed

Fig. 10. Postmortem specimen of a joint in which both cruciate ligaments have been reconstructed, obtained 9 months following operation. Joint firm. Operation a success.

In closing the anterior wound we try to pick up any vessels with open mouths and ligate them. Then we close this capsule with continuous catgut suture, one from below up, and one from above down, leaving a space between. We feel that the hemorrhage which will certainly follow this procedure can escape through the opening in this capsule and the skin is closed loosely with clips so that there will be no accumulation of fluid in the knee joint.

In the 2 operations for the repair of the posterior cruciate ligament the same method has been used as detailed for the posterior cruciate in the preceding paragraph. This operation was done upon an individual who had a rupture of both cruciate ligaments in the left knee and a rupture of the posterior cruciate ligament in the right knee. The first operation was performed in September for the posterior cruciate ligament in the right knee. The second operation was performed 3 weeks later for the double cruciate ligaments of the left knee. This man made a perfect recovery from each operation. There was no shock, no trouble of any kind. He was walking along very comfortably and it was not even necessary for him to use a cane. About July 1, 1935, he died suddenly from an unknown cause. No postmortem examination was made. Much to our horror he was interred in the potter's field, where he remained for 3 weeks. However, we were able to obtain a permit to have his body exhumed and reclaimed the knee joints. It is needless to add that an interment of 3 weeks' duration during the hot weather seriously interfered with any histologic study as to the life in the ligaments. But we submit here 2 drawings made of these joints following an incision which allowed the patella to be retracted laterally, exposing the ligaments as they are. In the right knee the anterior cruciate ligament which was noted to be hypertrophied at the time of operation, can be seen with its increased size still present, with the posterior cruciate ligament coming up behind and, apparently, inserted fanwise in the condyle of the femur. In the left knee joint the ligaments appear to be thinner; in fact, they are so thin we will definitely increase the size of the transplanted fascial strip in the future.

But the limbs are *in situ* and apparently healthy and strong. No abnormal mobility of any kind is present in either of the knee joints.

There was some fibrous arthritis and a partial obliteration of the suprapatellar space in both knees, but the cartilaginous surface of the joints were all clean and healthy, as shown in the illustrations.

It is well to state here that in reconstructing a single cruciate ligament it is somewhat difficult to get the posterior cruciate through when the anterior cruciate remains in position. If the anterior cruciate ligament is ruptured, there is a clear field and no difficulty is presented.

One must be certain to have these ligaments in their normal relation or the joint will not function in a normal manner. The operation that we have detailed to you causes these ligaments to go in an oblique direction through the joint and serves to stabilize the joint, both anterior and posterior, as well as lateral.

## CONCLUSIONS

1. The best time to treat injuries of the cruciate ligaments is at the time the injury is received.

2. The diagnosis of either single or double ruptured cruciate ligaments is best made with the patient under a complete anesthesia of some kind at the time the injury is received.

3. We are sure that complete dislocations of the knee joint make excellent recoveries if completely immobilized for 4 months, but not so sure about injuries to the single ligaments because of our insufficient experience in that line.

4. The operative repair of both single and double cruciate ligaments can be carried out with safety and with excellent results. In our cases there has been no danger of a stiff knee joint. It is better to immobilize for too long than for too short a period. It requires at least 1 full year for complete recovery, but at the end of 6 to 7 months the patient can get along with a brace or support of some type.

# SALIVARY CALCULI

## Their Treatment by Catheterization and Dilatation of the Duct

HARRY C. BALLON, M.D., F.A.C.S., and DAVID H. BALLON, M.D., F.A.C.S., Montreal, Quebec

CALCULI in the salivary glands or their ducts which produce symptoms should be removed on most occasions. This can be accomplished best through an incision into the duct, or when the calculus is so situated by excision of the gland. There are some few occasions, however, when such treatment is either impossible or refused. Associated trismus or severe infection in the gland may necessitate delay. The inability to demonstrate with the roentgen-ray the presence of a stone, the necessity of employing a general anesthetic, or the fact that stones were previously removed and new ones have formed may deter the patient from submitting to an operation. These circumstances occasionally force one to resort to therapeutic measures other than those already mentioned. Ivy and others have pointed out that the primary object of the treatment is the relief of the obstruction to the flow of saliva. Repeated catheterization and dilatation of the offending duct, whenever it is possible, may accomplish this very thing as the following cases illustrate. It is only in Cases 3 and 4 that we attribute the successful outcome to catheterization and dilatation of the duct *per se*.

Assistant Surgeon, Jewish General Hospital.
Otolaryngologist in Chief, Royal Victoria Hospital, Montreal.

CASE 1. This patient, a male aged 40 years, presented himself on September 15, 1933, complaining of a painful swelling below the left jaw, fever, and difficulty in opening his jaws. The swelling which would come and go had been noted intermittently for 6 months. The other complaints were only of 4 days' duration. The pain was colic-like, and was increased by the sight of food or by eating. The temperature was 103 degrees. Physical examination revealed considerable trismus and a swollen tender submaxillary gland on the left side. The patient refused hospitalization. Roentgenograms revealed a calculus in the region of the left submaxillary gland; the right side was free. There was an impacted molar on the left side. It was possible to introduce a probe into the duct for a considerable distance but only a small amount of pus followed the withdrawal of the probe which did not permit one to palpate the stone (Fig. 1). The patient was advised to apply heat externally. Absorbent cotton moistened with hot boracic acid was employed under the tongue and the mouth was irrigated at intervals. The following day it was possible to probe the duct much more readily since the patient could open his jaws more. At this time, although in great pain, the patient would permit only those procedures which could be carried out under local anesthesia. The absence of much palpable induration about the duct suggested that it might be safe to employ a local anesthetic. A probe was introduced into the duct as far as it would go. Under local anesthesia the probe together with the overlying mucous membrane of the mouth were grasped with a forceps. An incision was made into the duct as far back as possible.

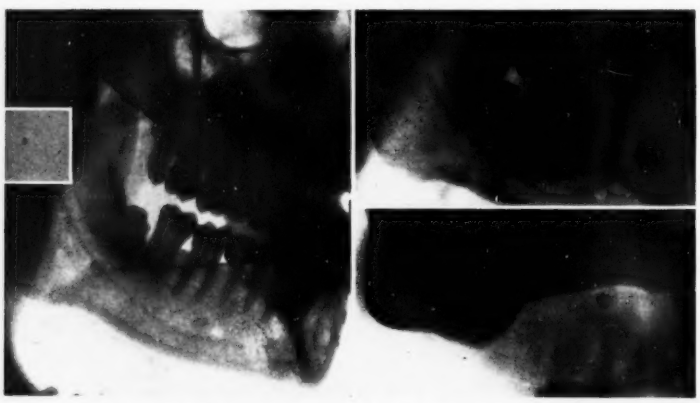

Fig. 1. Case 1. Left, the probe is seen in the duct, also the calculus beyond it. Note the impacted molar tooth, subsequently removed. Right, upper and lower, taken at different angles clearly demonstrate that the shadow under suspicion is not in the mandible. The insert shows the calculus passed in this case

Fig. 2. Case 2. No calculus is visible in this case. Note the acute angle the probe takes after it enters the duct. After repeated dilatations it was possible to pass the probe for a greater distance. The insert shows the calculus passed in this case. Below, the probes used were of brass (the shaft .020 inch, the head .032 inch) and of stainless steel (.025 inch and .040 inch, respectively). They were prepared for us by B. L. Hyams, D.D.S.

Probing of the duct through the new opening resulted in the escape of considerable pus. The stone could not be reached. The patient was encouraged to continue with the local applications of heat. The following day both fever and pain were less marked. The hot applications under the tongue helped to promote the flow of pus and saliva. The duct was again probed and dilated on the following day. Two days after the duct had been incised, a small calculus escaped through the new opening in the duct. A film taken 3 days later indicated that the originally visualized calculus was still present. Since the stone passed was radiopaque, it was concluded that fragmentation of the stone might have occurred. It is our opinion that we were dealing with 2 stones in this case. The visualized calculus was obviously in the gland. By October 3 the gland had almost returned to its normal size. The patient was urged to have the stone in the gland removed at a future date if his original complaints returned. Up to the present time the patient has had but little discomfort from the gland. He has reported for probing and dilatation of the duct at intervals. He was last observed during March of 1936, when he stated that he was free from complaints. We do not wish to make the implication that this patient may never have another attack. It would be unfair for us to attribute the expulsion of the stone from the duct entirely to any one procedure in this particular case.

Case 2. A male, aged 19 years, was first observed on April 17, 1934. His chief complaint was a painful swelling below the left jaw. Pain had been present for 10 days,

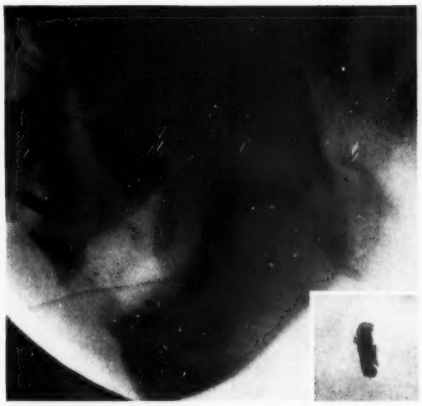

Fig. 3. Case 3. The probe in this instance could be passed eventually, as indicated, along the entire course of the duct. Insert shows the calculus previously removed from this patient.

but for many months he had obviously had intermittent blocking of the left submaxillary duct. The swelling was hard, painful, tender, and about the size of a golf ball. Examination of the oral cavity revealed a drop of pus at the mouth of the left submaxillary duct. The duct was palpably indurated. Roentgenographic examinations suggested the presence of a calculus in one film only. The duct was probed for a short distance (Fig. 2). Heat was employed locally in the manner indicated in the previous case. The following day it was possible to introduce the probe for a greater distance. Dilatation was carried out daily and was followed, on each occasion, by a discharge of pus. Six

Fig. 4. Case 4. Note the probe in the parotid duct and the calculus above it. The insert shows the second calculus removed from this patient's parotid duct.

days after the first treatment a profuse discharge of pus was followed by the escape of a stone. An opening could be observed in the duct just beyond the point where obstruction had been met. Dilatation of the duct in this case helped to promote drainage. The formation of a local abscess and decubital ulcer probably contributed to the rupture of the duct and the escape of the stone. This boy's mother was against any cutting operation at all times. It is appreciated that the spontaneous expulsion of calculi from the submaxillary duct does occur and that it might have occurred in this case without any treatment.

CASE 3. In this instance the patient, a female aged 60 years, had previously had a large stone removed from the left submaxillary duct (Fig. 3). Some 2 years later she noted the return of many of her original complaints. An attempt was made to inject the duct with lipiodol but was only partially successful. An obstruction was noted about ½ inch from the mouth of the duct. After the duct had been probed and dilated for the third time on successive days, there was an escape of considerable purulent material which contained many sand-like particles. It was then possible to introduce a probe beyond the original point of obstruction as far as the gland. The gland previously enlarged gradually returned to its original size. Roentgenograms in this case failed to demonstrate the presence of a calculus. This patient has been instructed to have the duct probed and dilated at intervals.

CASE 4. In this instance the patient, a male aged 52 years, complained of lack of saliva on the right side of his mouth. His right parotid gland had become swollen on numerous occasions. This was usually attributed to mumps. The gland would sometimes swell up after he had eaten, but by manipulating his jaw and cheek the patient was able to make the swelling disappear. It was not until February, 1935, that treatment was directed to Stensen's duct, right. From that time on it was probed and dilated at intervals (Fig. 4). It was possible to palpate the visualized calculus. On November 9, 1935, with the aid of a forceps, a calculus was withdrawn from the duct. On January 4, 1936, this patient's original complaint returned. The duct was again probed and dilated at intervals. Another stone about half the size of a pea gradually worked its way up to the mouth of the duct and was delivered by means of a hook on January 14, 1936. In this case there can be but little doubt that the probing and dilatation of the duct made it possible for the stones to pass along to the mouth of the duct. Their removal was then a simple matter.

We have had 3 other cases all treated in a similar manner with good results.

## SUMMARY

Symptom producing calculi in the salivary glands or their ducts should be removed. This is usually accomplished by incising the duct and withdrawing the calculus or, when indicated, by excision of the gland. There are occasions when this type of treatment is either refused or inadvisable. We have presented some experiences which would tend to indicate that repeated catheterization and dilatation of the obstructed duct may be of value in certain instances.

# THE DIFFERENTIAL DIAGNOSIS OF ECTOPIC GESTATION BY PERITONEOSCOPY

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PERITONEOSCOPY has been established as a definite diagnostic adjunct. It is not a new procedure (4), as visualization of the abdominal cavity by means of instruments with a lens system was first attempted by Kelling in 1901 in animals, and by Jacobus in man in 1910. At the present time in Europe, peritoneoscopy is being used in numerous countries by various men (5, 8). In this country, perhaps because of lack of development of adequate instruments, it has not been used generally. The Ruddock peritoneoscope is an adequate instrument for visualization of the abdominal cavity and contents. This has recently been developed and is equipped to obtain biopsy material from tumor masses with control of any hemorrhage that might ensue. With such an instrument the possibilities for differential diagnosis become evident in selected cases. In such cases peritoneoscopy can well be used to the benefit of the physician; but more so to the benefit of the patient in the saving of time, money, and the pain of unnecessary laparotomies or in indicating laparotomies when needed.

The procedure is not intended to replace surgery nor to be used as a short cut in making a diagnosis. It is not the purpose of this paper to rediscuss this subject in general or to describe the instruments and procedure in detail (Fig. 1). The author feels that the value of it has been well established in a large series of cases (6, 7). The object of this paper is to point out one particular field in which peritoneoscopy is of inestimable value in differential diagnosis; namely that of extra-uterine pregnancy. A number of case histories will be cited to show this.

It is not always a simple matter to decide whether or not a pregnancy is uterine or extra-uterine (2). Indeed, until the advent of the various biological tests for pregnancy, it was often difficult to differentiate pregnancy alone in a given condition for which a woman might consult her physician. Thanks to these valuable tests it is now possible to make an early diagnosis of pregnancy, in the face of conflicting symptoms and signs, with a high percentage of accuracy. The physician is in a dilemma when consulted by the patient definitely known to be pregnant, who is "spotting," or having pain of severe type in the lower abdomen, or both. Pelvic examinations are often of little aid, especially when the pregnancy is early, and may only add to the confusion of the picture. A careful and accurate history is of great value (3). Much help is obtained by blood counts, sedimentation time, and biological tests for pregnancy. However, often after applying all the data obtained we are still faced with a problem and are uncertain whether a laparotomy is justified. In the face of a definite ruptured tubal pregnancy with marked hemorrhage and the accompanying signs and symptoms the diagnosis is not as difficult. In most cases there is some definite indication that the patient has a surgical abdomen.

De Lee (1) in his textbook states, "Before rupture of the tube or hemorrhage into it, the diagnosis of ectopic gestation has hardly ever been made, because the tube is as soft as an intestinal loop." Again, "No pelvic condition gives rise to more diagnostic errors. The author has seen mistakes made by every gynecologist and surgeon in the city, including himself."

Many cases of intra-uterine pregnancy that have been "spotting" or bleeding, accompanied by some pain in the lower abdomen, have been subjected to a laparotomy because the physician felt that this was the safest procedure. It is in these particular instances that we feel peritoneoscopy is of value; for by this procedure we have a method of actually seeing the uterus, fallopian tubes, and ovaries. This procedure is done under local anesthesia and requires but 24 hours of hospitalization. Should the peritoneoscope determine that the patient has intra-uterine pregnancy, the danger of aborting is less likely than following a laparotomy. The patient may return home for expectant treatment, with a saving of several weeks of hospitalization for postoperative care and of much discomfort, as well as a saving of money. If, on the other hand, an ectopic gestation is seen, immediate laparotomy is done. Both the physician and patient are thus saved the time, worry, and possible risk of delay by indecision.

Read before the Obstetrics and Gynecology Section of the California Medical Association at the sixty-fifth annual session, Coronado, May 25–28, 1936.

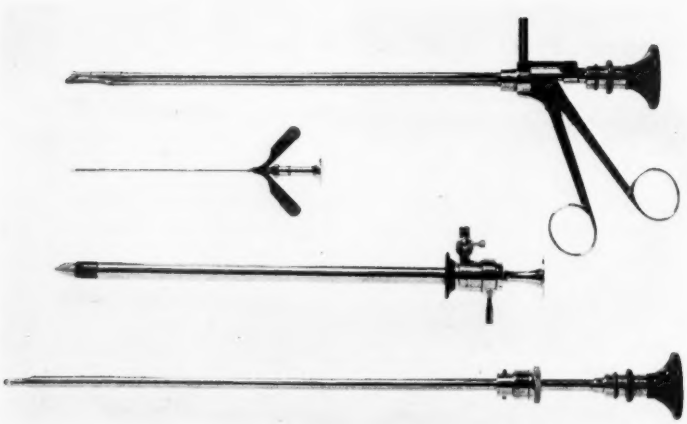

Fig. 1. Photograph of instruments, from above down: biopsy forceps and telescope, pneumoperitoneum needle, trocar point and sheath, visual telescope.

The examination is carried out along the general rules for peritoneoscopy and only its special features will be described here. The procedure is done in a surgery which is in readiness for an immediate laparotomy if indicated. The patient is given pre-operative medication of morphine and scopolamine or morphine and a barbituric preparation, dosage depending on her condition, weight, and temperament. The abdomen is shaved as for laparotomy, and the skin prepared in the usual manner. It is of utmost importance to catheterize the patient just prior to doing the peritoneoscopy as a full bladder may obscure the view of the pelvis. Local anesthesia, using 1 per cent novocain, is infiltrated in a wheel formation, starting at a point in the midline about 4 centimeters below the umbilicus and taking in all layers down to and including the peritoneum. Should there be a scar from a previous laparotomy, the site for entering the abdomen with the trocar is chosen well away from it, to avoid any adhesions that may be present. After anesthesia is established, a stab wound, 1 centimeter long, is made through the skin and rectus fascia. A small trocar is inserted into this, pushed through the peritoneum into the abdominal cavity. A pneumoperitoneum is then created by injecting air into the peritoneal cavity through the trocar using a small rubber manometer bulb. The small trocar is withdrawn and the trocar sheath inserted into the peritoneal cavity through the stab wound safely as the intestines are held down by a cushion of air. The trocar point is removed from the sheath and the visual telescope inserted. Any air that has escaped is now replaced, as air is essential for good visualization as well as a means of displacing the viscera. A general rapid survey of the peritoneal cavity is then made, going completely around the clock. The patient is then placed in extreme Trendelenburg position which allows the intestines to fall back out of the pelvis and a detailed examination made of the uterus and adnexa. This is greatly facilitated in many cases by an assistant placing two fingers in the vagina and manipulating the uterus and adnexa (Fig. 2). By this means the uterus can be pushed up into view if dropped far back into the pelvis, a prolapsed ovary brought into sight, and adhesions and fixation of the uterus demonstrated. It is also a valuable means of orientation when there are masses present which distort normal relationships. On completing the examination the patient is replaced in the horizontal position, the air is allowed to escape from the peritoneal cavity through the instrument, and the latter is removed.

If an ectopic gestation or hemoperitoneum is found the patient is then subjected to surgery immediately. The skin is reprepared, new drapes placed, and the stab wound incorporated in the usual laparotomy incision. However, if an intrauterine pregnancy is found and there is no supervening condition that requires immediate surgery, a single dermal stitch or skin clip is placed in the stab wound. The patient is then sent back to bed, care being taken that she stays in the prone position for 12 to 24 hours to prevent shoulder

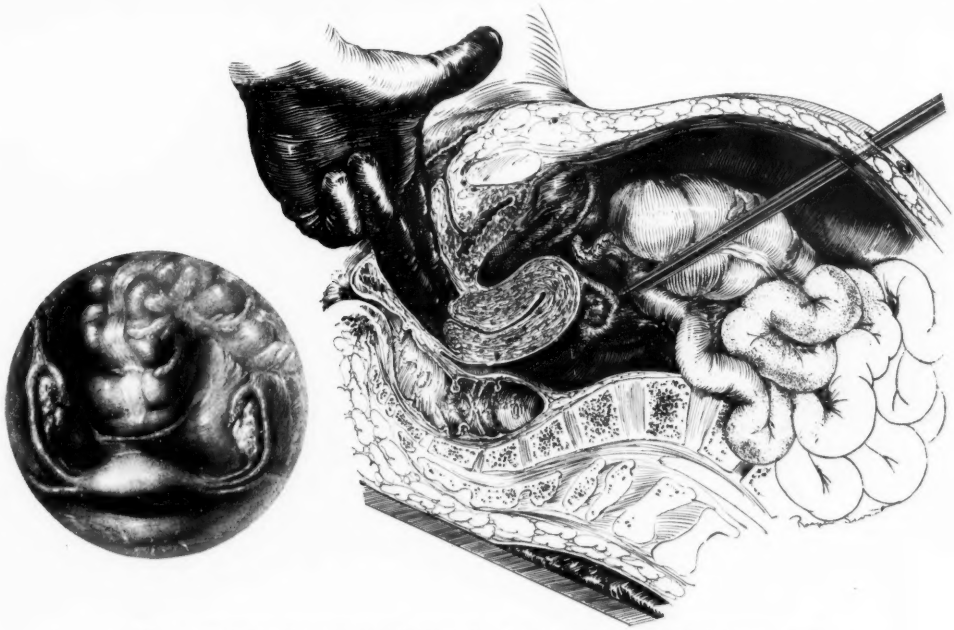

Fig. 2. Diagram, showing visualization of pelvis. Inset, view of pelvic organs as seen through telescope. (Courtesy of Dr. John C. Ruddock.)

pain. There is no distress from inflation of the abdominal cavity or from any small amount of air that may be left after the procedure unless the patient sits or stands upright. In that position she is apt to have severe shoulder pain as is common in the Rubin tests. After 24 hours any air left is absorbed. There is no special care or hospitalization necessary from the peritoneoscopy *per se*. Further treatment will depend on the findings and diagnosis made and is a separate problem that we are not concerned with in this paper.

The findings vary with the nature and extent of the pathology present. There is no distortion of natural colors. It is remarkable how much can be seen. If on first attempt at visualization a frank hemoperitoneum is found the diagnosis is self-evident. While hemoperitoneum is not always an indication of a ruptured tubal pregnancy, as will be shown by one of the cases to follow, it definitely indicates a surgical abdomen. There is no need for further exploration of the abdomen with the peritoneoscope when a hemoperitoneum is found. It would only delay surgery unnecessarily and probably yield no additional information as blood on the lens system obscures vision. The hemoperitoneum may be manifested as soon as the trocar point is removed from the sheath prior to inserting the telescope, by a frank flow of fresh or old blood. In some cases, however, it is found only after visualization of the peritoneal cavity as pools of blood seen between coils of the intestine. Again it may not be demonstrated until the patient is placed in Trendelenburg position and the pelvis seen. The whole pelvic cavity may be filled with clotted or free blood or a large hematoma incorporating one of the tubes may be seen. We have visualized an enlarged fallopian tube containing an ectopic gestation from which a small slow trickle of bright blood could be seen with a large clot below it in the pelvis. Where there is no bleeding the dilated portion of the tube with its apparent pathology is seen.

The intra-uterine gestation shows the enlarged uterus with its dilated vessels and typical purplish color that is rarely mistakable. The adnexa may or may not be normal. As most of our cases were done in the face of conflicting symptoms and signs and because of some lower abdominal pain, they show co-existing pathology in the adnexa along with the normal gravid uterus. In this series we have not seen an ectopic pregnancy coexisting with an intra-uterine one.

The following summarized case histories are presented to show some of the problems and the solution of them by this valuable diagnostic adjunct. Only the positive pertinent findings and history are given. May we again point out that this is not presented with a view to supplanting present methods of diagnosis but as a direct adjunct. We feel that in questionable cases it can definitely be used to decide by eye-control whether a case is surgical or demanding of expectant treatment.

## CASE HISTORIES[1]

CASE 1. (Los Angeles General Hospital No. 141–163.) Mexican, aged 34 years, quintipara, last menses ended May 27 and were normal. At 2 p.m., June 2, 1935, the patient developed sudden severe pain in the epigastrium and vomiting. There had been "spotting" for 2 days. The pain increased in severity, localized in the lower abdomen, vomiting continued, and she entered the hospital at 7 p.m. Past history was negative except for surgery in 1931 for a left ruptured tubal pregnancy and a tuberculous adenitis in 1934 with negative chest findings.

Physical examination on admission to the hospital disclosed slight rigidity on right side of abdomen with moderate tenderness over McBurney's point. The uterus was retroverted, slightly enlarged, and there was a small mass in right adnexa extending into the cul-de-sac. Laboratory tests showed: hemoglobin 72 per cent Sahli; red blood count 4,150,000; white blood count 13,400 with 79 per cent polymorphonuclears; urine normal; sedimentation time 20 minutes.

Because of the uterine enlargement a peritoneoscopy was done 4 hours after entry. There were no abnormal findings until the patient was placed in Trendelenburg, when the right tube was seen to be markedly enlarged, the distal half extending down into a large hematoma that filled the floor of the pelvis, the uterus larger than normal, but not of typically gravid color. A diagnosis of right ruptured tubal pregnancy was made. Immediate surgery followed with findings of right ruptured tubal pregnancy, non-gravid uterus. Convalescence was uneventful.

CASE 2. (Los Angeles General Hospital No. 409–175.) White, aged 20 years, nullipara, entered hospital August 28, 1935, giving a history of vaginal discharge for 2 years. Patient's last menses started August 5, lasted 4 days, and was normal. On August 28, at 11 a.m., she consulted a physician because of pain in lower left quadrant of 1 week's duration. During this examination presumably the tubes were insufflated. She immediately developed intense pain in lower abdomen which caused her to enter the hospital. There was no nausea or vomiting.

Physical examination on admission to the hospital disclosed a young woman, showing no apparent anemia but suffering acutely. Her pulse was 108; temperature 99 degrees F.; blood pressure 144/90. There was generalized tenderness of the abdomen, most marked in lower left quadrant, slight rigidity, no masses or distention. Pelvic examination revealed a nulliparous introitus; slightly softened cervix; corpus not enlarged, moderate induration of left adnexa with an indefinite mass extending into cul-de-sac. Laboratory tests showed hemoglobin 70 per cent Sahli; red blood count 3,800,000; white blood count 23,000 with 90 per cent polymorphonuclears; sedimentation time 78 minutes.

As picture was not clear peritoneoscopy was done at 11 p.m. to determine subsequent procedure. A hemoperitoneum was found as soon as visual system was inserted. Further exploration was not attempted. Immediate surgery followed with findings of: (1) ruptured ovarian cyst—right—with small bleeding vessel; (2) hemoperitoneum. Recovery was uneventful.

CASE 3. (Los Angeles General Hospital No. 181–271.) White, aged 23 years, unipara, last menses October 8, 1934, was attending the out-patient department of the prenatal clinic. On November 13, 1934, the patient fainted because of severe pain in the lower abdomen which lasted but a short time. On January 4, 1935, she was hospitalized for observation because of continuous lower abdominal pain and the fact that examination at the clinic suggested a possible bipartite uterus with pregnancy in left half. Pain continued while under observation; all physical findings were negative except the pelvic which suggested the following possibilities: (1) Bipartite uterus with pregnancy in left half; (2) intra-uterine pregnancy with inflammatory mass in right adnexa; (3) intra-uterine pregnancy with fibroid; (4) possible ectopic gestation.

Laboratory tests showed hemoglobin 70 per cent Sahli; red blood count 4,830,000; white blood count 9,100; urine normal; Friedman positive. Peritoneoscopy was done January 19, 1935, with findings of: (1) enlarged typically normal gravid uterus; (2) left ovarian cyst, size of large orange; (3) right adnexa normal. The patient was discharged and turned over to a private physician to go on with pregnancy.

CASE 4. (Los Angeles General Hospital No. 124–173.) Mexican, aged 39 years, septipara, entered the hospital January 23, 1936, because of severe abdominal pain of 3 days' duration. The patient had missed January menses; previous menses all normal. There were no other symptoms. Past history was negative except for a similar attack 3 years prior, diagnosed as pelvic inflammatory in this hospital.

Physical examination disclosed: pulse 88; temperature 98.6 degrees F.; blood pressure 120/86. There was slight generalized tenderness of the abdomen. The pelvic examination was unsatisfactory because of poor co-operation. Laboratory tests showed: hemoglobin 67 per cent; red blood count 3,400,000; white blood count 10,500 with 76 per cent polymorphonuclears; urine negative. The clinical diagnosis was mild flare-up of chronic pelvic inflammatory disease.

Because of missed period and normal temperature, peritoneoscopy was done January 24, 1936. A hemoperitoneum was found. Immediate surgery followed with findings of: (1) right ruptured tubal pregnancy, with hemoperitoneum; (2) left tube and ovary bound down in inflammatory mass. Convalescence was uneventful.

CASE 5. (Los Angeles General Hospital No. 399–954.) White, aged 24 years, nullipara, entered hospital November 25, 1934, because of cramping, pains and a dull constant ache in the lower left quadrant of 1 week's duration, preceded by a scant brown vaginal discharge. The patient had no nausea or fever. Last menses, in September, was normal. She missed the October period. She admitted a Neisserian infection 7 years previous.

Physical examination disclosed: pulse 92; temperature 98.6 degrees F.; blood pressure 100/60. There was slight generalized rigidity of the abdomen, tenderness in the lower left quadrant. Cervix was softened, corpus definitely enlarged, and tender mass present in left adnexa, 3 to 5 centimeters in diameter. Laboratory tests showed hemoglobin 74 per cent Sahli; red blood count 3,960,000; white blood

[1] Since the presentation of this paper 11 additional cases have been done. Of these, 6 were diagnosed as ruptured ectopic pregnancies and checked by operation; 3 were diagnosed as intra-uterine pregnancies, 2 as chronic pelvic inflammatory disease and were saved from operation.

TABLE I.—SUMMARY OF CASES

| Case | Time entry to diagnosis | Clinical diagnosis | Peritoneoscope diagnosis | Diagnosis checked by | Follow-up |
|---|---|---|---|---|---|
| 1 | 4 hours | Ruptured tubal pregnancy | Ruptured tubal pregnancy | Surgery—ruptured tubal pregnancy | Convalescence uneventful |
| 2 | 4 hours | Ectopic gestation | Hemoperitoneum | Surgery—ruptured ovarian cyst—hemoperitoneum | Convalescence uneventful |
| 3 | 15 days | Bipartite uterus pregnancy left half | Intra-uterine pregnancy, left ovarian cyst | Positive Freidman | Turned over to private physician |
| 4 | 12 hours | Exacerbation Chronic pelvic inflammatory disease | Hemoperitoneum | Surgery—ruptured right tubal pregnancy | Convalescence uneventful |
| 5 | 12 hours | Left tubal pregnancy, unruptured | Left tubal pregnancy, bleeding | Surgery—ruptured left tubal pregnancy | Convalescence uneventful |
| 6 | 1 hour | Ectopic gestation | Intra-uterine pregnancy | Clinical signs and symptoms | 2 months later still carrying on |
| 7 | 8 hours | Ectopic gestation | Intra-uterine pregnancy, right ovarian cyst, subacute appendicitis | Positive Friedman | Symptoms abated 5 days, turned over to own Doctor |
| 8 | 12 hours | Ectopic gestation | Ruptured corpus hemorrhagicum | Negative Friedman | Discharged 5 days later—symptomless |
| 9 | 3 hours | Ectopic gestation ruptured | Intra-uterine pregnancy, bilateral salpingitis | Positive Friedman | Aborted 3 days after entry. Recovery uneventful |
| 10 | 7 hours | Ectopic gestation flare-up pelvic inflammatory disease | Hemoperitoneum, left tubal pregnancy bleeding | Surgery—left tubal pregnancy—aborting | Convalescence uneventful |

count 9,900; 72 per cent polymorphonuclears; urine normal; sedimentation time, 65 minutes. The clinical diagnosis was probable tubal pregnancy, unruptured.

Peritoneoscopy was done November 26, 1934, with findings of: (1) uterus enlarged but ungravid, normal color; (2) left cornu pulled posteriorly, by mass involving left tube, size of small orange. Slow trickle of bright blood oozing from mass into a pool in the pelvis. The diagnosis was left tubal pregnancy, leaking blood. Immediate laparotomy followed with finding of a left ruptured tubal pregnancy. Convalescence was uneventful.

CASE 6. (Cedars of Lebanon Hospital No. 33645.) White, aged 37 years, nullipara, was diagnosed as having an ectopic gestation, in June, 1935. Although a Friedman test was positive, exploratory laparotomy was negative for any pathology or pregnancy. Recovery was uneventful. In December, 1935, she missed her menses and in January, 1936, developed pain in lower left abdomen. She also noted severe distress during intercourse. She began to "spot" intermittently and to have "morning sickness." On February 21, 1936, she entered the hospital for peritoneoscopic consultation.

Physical examination disclosed: pulse 84; blood pressure 114/80; temperature 98.8 degrees F. All findings were negative except: Pelvic examination showed a nulliparous introitus. There was marked tenderness on bimanual examination, especially on moving the cervix and there was an indefinite, exquisitely tender mass in the left adnexal region. It was impossible to delineate corpus because of tenderness. All laboratory findings were within normal range. The clinical diagnosis was tubal pregnancy.

Peritoneoscopy was done 1 hour after entry, which showed the mass in the left side to be uterus, enlarged to approximately the size of a 3 months' pregnancy. The uterus was pulled to the left by adhesions to the omentum, surface of the uterus was markedly injected. Left tube was seen to be normal throughout. Right tube and ovary were tied down under omentum. No free blood was noted in peritoneal cavity. The diagnosis was probable intra-uterine pregnancy with mild superimposed inflammation. One month after peritoneoscopy, clinical check-up showed definite intra-uterine pregnancy.

CASE 7. (Los Angeles General Hospital No. 465-942.) White, aged 23 years, secundipara, sent into hospital November 6, 1935, because of severe continuous pain in lower right quadrant for 1 month and "spotting" for 1 week, no nausea. The patient's menses had been very irregular for past 6 years. Last period was September 24, 1935. Physical examination showed: temperature 98.6 degrees F.; pulse 84; blood pressure 110/74. Abdominal examination was negative. Pelvic examination showed a multiparous introitus, cervix softened, mobile, no bleeding, corpus enlarged, soft, size of 3 months' pregnancy. A small tender mass was seen in right adnexa. All laboratory findings within normal range. Clinical diagnosis was possible ectopic pregnancy.

Peritoneoscopy was done November 7, 1935, with findings of: (1) enlarged uterus, typical color and appearance of 3 months' gravid uterus; (2) simple cyst of right ovary, 4 to 5 centimeters in diameter; (3) appendix visualized, sharply kinked distal one-third, whole length showed definite subacute inflammation. The pain subsided with rest and the patient was discharged November 10, 1935, to go on with pregnancy under care of private physician.

CASE 8. (St. Vincent's Hospital No. D4457.) White, aged 35 years, nullipara, married 4 weeks, last menses December 6, 1935, normal but 1 week late. On January 1, 1936, about 1 p.m., the patient developed a sudden severe pain in lower abdomen which made her feel faint, nauseated, and which increased in severity, localizing in the lower left quadrant. Her past history was entirely negative. At 4 p.m., when she entered the hospital the abdomen was very tender and pelvic examination was not possible because of pain. A few hours later abdominal tenderness was less marked. Pelvic examination revealed an indefinite mass in left adnexa, normal uterus. By next morning a

definite mass the size of a small orange was palpable. Laboratory tests showed: hemoglobin 72 per cent Sahli; red blood count 4,090,000; white blood count 19,400 with 81 per cent polymorphonuclears; urine normal; Friedman test taken January 2, 1936, reported January 4, 1936, was negative. Clinical diagnosis was probable ectopic gestation.

Peritoneoscopy was done January 2, 1936, which showed a small amount of dark brownish fluid in the pelvis. Left tube was normal, situated over red mass size of small orange, at base of which was an area of bluish-black discoloration (cyst filled with blood). Uterus and right adnexa were normal. The diagnosis was ruptured corpus hemorrhagicum. (Friedman test returned 2 days later negative.) The patient was kept at rest in bed, the pain eased gradually. She was discharged January 6, 1936, with no symptoms.

CASE 9. (Los Angeles General Hospital No. 380–010.) White, aged 28 years, tripara, entered hospital January 22, 1936, because of very severe, cramplike pain in lower abdomen which started at 2 a.m. and caused her to feel faint and nauseated and break out in a cold sweat. There had been dull "cramps" for 12 days, some dysuria and a slight bloody vaginal "show" for 1 day. Her menses always were irregular; she was 12 days overdue at time of entry. She denied any interference. Physical examination showed: blood pressure 110/70; pulse 92; temperature 100.6 degrees F. The abdomen was flat. There was definite rigidity in both lower quadrants, and generalized tenderness both on pressure and rebound. There was marked tenderness on moving uterus and cervix and a questionable mass in left adnexa. Laboratory tests showed: hemoglobin 80 per cent Sahli; red blood count 4,000,000; white blood count 15,000; 90 per cent polymorphonuclears; urine normal; sedimentation time 60 minutes. Friedman test taken January 22, 1936, reported January 25, 1936, was positive. The clinical diagnosis was ectopic gestation.

Peritoneoscopy was done 3 hours after entry. It showed intestines to be somewhat distended and injected. Uterus slightly enlarged and injected; left tube dilated about 1 centimeter in diameter; right tube very tortuous, with marked dilatation at distal end; both tubes were very markedly inflamed; the ovaries were not visualized. The diagnosis was bilateral salpingitis; if present, pregnancy intra-uterine. Subsequently the vaginal flow increased, the patient passed clots and on January 25, 1936, passed placenta and membranes. Her temperature returned to normal slowly. Pain ceased after aborting.

Case 10. (Los Angeles General Hospital No. 480–167.) White, aged 31 years, nullipara, last normal menses November 21, 1935, lasting 4 days. On December 17, the patient started to flow heavily for 3 days and continued to spot daily. December 24, she began to have pains in lower left quadrant, associated with nausea and faintness. These increased in severity, causing her to enter the hospital January 30, 1936, at 4 p.m. Physical examination showed: pulse 92; temperature 99.6 degrees F.; blood pressure 120/70. The abdomen was flat. There was tenderness on pressure and rebound in lower left quadrant; rigidity in both lower quadrants; and a questionable mass on the left side. The cervix was softened. There was severe pain on moving the uterus. Corpus was slightly enlarged and pushed to right. A large tender mass was present in the left side of adnexa. Laboratory tests showed: normal urine; hemoglobin 70 per cent Sahli; red blood count 3,940,000; white blood count 12,600; polymorphonuclears 75 per cent; sedimentation time 30 minutes. The clinical diagnosis was probable left ectopic pregnancy, pelvic inflammation also possible.

Peritoneoscopy performed 7 hours after entry, showed pools of fresh and old blood between coils of intestines. A large mass filling left lower abdomen was covered with omentum. The uterus was slightly larger than normal and flecked with fresh blood. A large clot filled the floor of the pelvis. The right tube was tortuous, intact, and ovary was not seen. The left tube and ovary were incorporated in the mass. The diagnosis was hemoperitoneum and ruptured left tubal pregnancy. Surgery followed immediately with finding of a left tubal pregnancy bleeding through the fimbriated end. Convalescence was uneventful.

## SUMMARY AND CONCLUSIONS

The diagnosis of ectopic gestation is not always simple. In the differential diagnosis, peritoneoscopy is a valuable adjunct. It is a safe procedure and in cases of intra-uterine pregnancy, abortion is far less apt to occur after it than after laparotomy. In questionable cases peritoneoscopy can be used to determine by direct eye-control whether surgery or expectant treatment is indicated. Ten case histories are presented to show the value of the procedure in this field.

I wish to acknowledge my gratitude to Dr. Lyle McNeil for making available for this paper cases from the Obstetrical Department of the Los Angeles General Hospital; and to Dr. John C. Ruddock for allowing me to include several of his cases in this series.

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# THE TREATMENT OF PERFORATED DUODENAL ULCERS

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THE basis of this communication is a series of 51 cases in which operations were performed by the Staff of the First Division of the Toronto General Hospital from July 1, 1929, to November 1, 1935. It is interesting to note that of this group, there were 46 males and only 5 females. The youngest patient was 16 years and the oldest was 82 years. There occurred 27 perforations in patients between the ages of 40 and 49, and the average age of the whole group was 45 years.

In only 7 cases was perforation the first symptom of the disability. In only 6, however, had previous roentgen-ray examination been carried out. Five of these showed roentgenographic evidence of ulcer, and in one this evidence was absent. The interval between the recognition of the perforation and the admission of the patient to hospital varied from 2 to 60 hours, with an average interval of 7 hours. It is a tribute to the family physicians who were first called to see this group of patients, that an average interval of only 7 hours elapsed between the perforation and the admission of the patient to hospital.

In the vast majority of cases the diagnosis of the perforation is relatively easy. The previous history of a periodic type of indigestion, occurring after meals and relieved by food, gives one a clue to the presence of a duodenal ulcer. For a few days prior to the perforation, in about one-third of the cases there was an aggravation of symptoms. The sudden onset of the pain, of such severity as to make the patient stop when it occurs, is typical. In this group of cases it was interesting that pain in the right shoulder was a very common complaint. Rigidity, in the vast majority of cases, comes on very early, and is widespread over the whole abdomen. However, one must not lose sight of the fact that perforation of a duodenal ulcer may occur when, if the patient be seen very early after its occurrence, abdominal rigidity may be absent or doubtful. The comfort of the patient, the calm expression, normal temperature and normal pulse rate, which such patients exhibit after the initial shock passes off, create a dangerous interval when the unwary may be lulled into inactivity. Abdominal examination, however, presents irrefutable evidence of a serious lesion.

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We have accepted a trinity of symptoms and physical findings indicative of an acute intraperitoneal tragedy, which has been of real aid, and as accurate as any clinical dogma can be. They are: (1) the association of pain and tenderness; (2) one point of maximum tenderness; (3) aggravation of the distress if the patient turns over in bed. If these are present, we accept the diagnosis of an intraperitoneal catastrophe. In extraperitoneal lesions simulating acute intraperitoneal disease there is no association of pain and tenderness, i.e., in basal pneumonia of the right lung, the patient may complain of pain in the right iliac fossa, but tenderness is absent on palpation.

The real differential diagnoses which present difficulty are: (1) acute appendicitis; (2) acute hemorrhagic pancreatitis; (3) coronary thrombosis.

In this study there was no case in which operation was done and patient subsequently was proved to be suffering from coronary thrombosis instead of duodenal ulcer. On the other hand, we have been consulted on many occasions when real difficulty was presented in differentiating between a coronary thrombosis and a perforated duodenal ulcer. The pain in coronary thrombosis is more insidious, and its evolution is sufficiently slow to enable the patient to reach some place convenient after the onset of pain. This is not true in a perforated duodenal ulcer. The radiation of the pain of coronary thrombosis is up over the left chest, and there is no abdominal muscular rigidity. There is no point of maximum tenderness; there is dissociation of pain and tenderness, and pain is not aggravated by turning in bed.

Acute hemorrhagic pancreatitis was an erroneous diagnosis made in one case in this group. In that case the patient was seen very early, and generalized rigidity had not developed.

In 4 patients a diagnosis of acute appendicitis was made. This is explained by the drainage of the duodenal content down the right paracolic gutter and puddling about the cecum, thus giving very intense local signs in the right iliac fossa.

Only 41 per cent of these patients vomited before operation. The value of liver dullness in the diagnosis of a perforation is not of as great importance as one would be led to believe from the ordinary textbook descriptions of this catastrophe. Other lesions, notably a distended colon, can give clinical evidence of loss of liver dullness.

However, if it be possible, in a questionable case, to take a flat roentgenographic plate centered on the dome of the diaphragm, gas will be shown to occupy the subphrenic space. This we believe is pathognomonic of perforation of a hollow viscus, unless the plate be taken after operation after patient has had a spinal anesthesia. Dr. F. I. Lewis reported a series of cases in which air occupied the subphrenic space after a laparotomy under spinal anesthesia for periods varying to 6 weeks.

The fundamental surgical principle applicable to all emergency surgery—that the patient be treated solely for the lesion creating the emergency—should be observed to a greater degree in the treatment of patients suffering from an acute perforation of a duodenal ulcer than in almost any other acute intraperitoneal lesion. We have no responsibility to such patients but to save their lives. Any procedure of a more extensive character, which aims to do more than this, under the conditions and circumstances attending the perforation of a duodenal ulcer, can quite justifiably be considered meddlesome surgery. We have no responsibility during the emergency, to carry out any procedure designed to cure the patient of his original duodenal ulcer. Many patients who come for operative therapy after the lapse of many hours following perforation, are suffering more from the secondary manifestations of perforation than from the direct result of this accident. This is well exemplified in 2 patients in this group.

A man 70 years of age was admitted to hospital at 9:00 p.m., when he was seen by Dr. Harold Couch. His pulse was rapid; his extremities were cold, and he presented the clinical picture of extreme shock. To have immediately submitted this patient to a laparotomy would in all probability have resulted in a fatality. Rather did Dr. Couch treat the secondary manifestations: Morphia allayed pain; heat was applied; fluid balance was restored by the intravenous administration of saline, glucose, and blood. It was not until 8 hours after admission that it was felt the patient's condition had been sufficiently improved to warrant operative interference.

The second case was a male, aged 75 years, who had refused early operation and was admitted 60 hours after the perforation. He was cold, dehydrated, and in shock. Local application of heat, sedatives, and administration of intravenous fluids over a period of 8 hours so improved his condition that an apparently hopeless problem was solved with success.

We submit that the additional 8 hours' duration of these perforations was justified by the improvement which it was possible to obtain by adequately treating the secondary manifestations. Following operation both patients had a satisfactory convalescence. This again exemplifies what we believe to be true: Recognize the factors responsible for creating the emergency; correct the associated biochemical disturbance, and deal with the local lesion by the most simple and atraumatic procedure possible. In these particular instances the most brilliant technical procedures we believe would not have saved the patients' lives without the application of the above principles.

The anesthetic we believe is of the utmost importance in this group of patients. The extreme respiratory effort which accompanies inhalation anesthesia produces a plunger action of the liver through movement of the diaphragm: this greatly accelerates the dissemination of the duodenal contents throughout the peritoneal cavity. Spinal anesthesia, on the other hand, produces the still abdomen with which we are all familiar. That this is no idle theory was demonstrated by Dr. Stuart Gordon following the injection of dyes into the peritoneal cavity of animals and comparing the dissemination in inhalation anesthesia with that in spinal anesthesia. The animals with inhalation anesthesia had very much wider dissemination of the dye throughout the peritoneal cavity than did those given spinal anesthesia. While evidence can be submitted that spinal anesthesia carries with it a higher immediate risk than inhalation anesthesia, yet if one weighs against this added risk, the added advantages, our conclusion is that the sum total is vastly in favor of patient operated upon for a perforated duodenal ulcer under spinal, rather than inhalation, anesthesia.

The actual operation we believe should be of the most simple character. If we close the perforation, we restore the patient to the state in which he found himself before the ulcer perforated. Having achieved this, we should feel that we have accomplished all we are called upon to do at this time. The procedure which we use could not be more simple: Three interrupted catgut sutures are used. One is placed at the top, one in the middle, and one at the bottom of the perforation (Fig. 1). A piece of omentum, either free or attached, is laid over these sutures, which are then tied just sufficiently tight to hold the omental graft *in situ*, but not with sufficient force to cause the sutures to cut out, even in the most edematous indurated ulcer. No attempt is made actually to close the perforation (Fig. 2). It thus becomes obvious that no perforated duodenal ulcer is difficult to close.

All are familiar with the thoroughly futile attempts at infolding a chronic indurated duodenal ulcer which has perforated. The formation of fibrin produces the real closure. The free omental graft provides the stimulus and the scaffolding for this formation. No exploration should be done. The appendix should not be explored. This simple procedure occupies not more than 5 minutes after

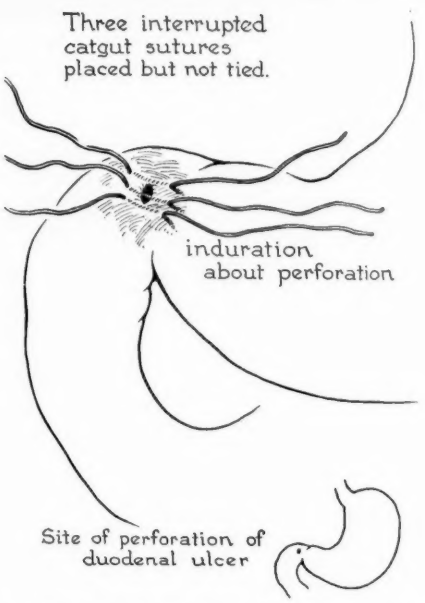


Fig. 1. The placing of sutures in relation to perforation.

Fig. 2. Sutures tied over free omental graft. No attempt is made to close the perforation by the suture. They are tied only sufficiently tight to hold the graft *in situ*.

the abdomen is opened, and is accompanied by a minimum of trauma. The recognition of the perforation requires no manipulation. This lack of trauma to the inflamed tissues we believe is an important part of the procedure. There is no breaking down of any barrier which the inflammatory process has produced. To add a gastro-enterostomy at this stage we believe is unnecessary to save the patient's life, and being unnecessary, must therefore be but meddlesome. That a pyloric obstruction might occur or be present does not in the least alter the situation. One patient in this group was on our division being prepared for operation for what we recognized as an almost complete scar stenosis of the duodenum from an old ulcer. Radiographically, very little barium left the stomach in 6 hours. While under treatment in hospital, the ulcer perforated. The method of closure described was carried out, and in 3 weeks an operation designed to deal with the obstruction was possible and successful. The use of intravenous fluid accompanied by an indwelling duodenal tube will tide any patient through the crisis of a pyloric stenosis. Therefore, in addition to being meddlesome and unnecessary, we believe that the doing of a routine gastro-enterostomy at this time may be highly disastrous.

In two of the cases in this series a coincident gastro-enterostomy was done. In one of these patients, 5 months later we were asked to operate for a perforated jejunal ulcer, and in the studies which we have been making of patients suffering from a jejunal ulcer, we are impressed with the increased frequency of jejunal ulceration in patients who have a gastro-enterostomy coincident with the closure of a perforation. Furthermore, we believe that gastro-enterostomy should be reserved solely for elderly patients having a scar stenosis with a low incidence of free hydrochloric acid on gastric analysis. A postoperative test meal was done in 18 of these cases, and the average incidence of free hydrochloric acid in these 25 cases was 50 clinical units, and in only 1 case was the acid sufficiently low to fall into the group for which we would think a gastro-enterostomy might be applicable, and yet that patient, a man of 43, is symptom-free with no further operative interference.

Having closed the ulcer in the manner which we have suggested, the question of drainage must be considered. A definite note regarding drainage was made in 46 of the 51 cases. Only 11 were drained. Cultures were taken on 30 of the 51 cases Of these cultures 20 were sterile, in one of which 12 hours had elapsed since the perforation. Of the 10

cases showing positive cultures there was only 1 which showed a pathogenic organism, and that was a pure culture of typhoid bacillus. This patient has been reported in detail by Dr. Clifford. In none was a hemolytic streptococcus recovered. The 7 other positive cultures contained various non-pathogenic or avirulent organisms. In this group we had only one operative death. In 49 consecutive cases operation was done without a fatality. The fiftieth patient died suddenly on the twelfth day after operation, of a pulmonary embolus. Autopsy showed a massive pulmonary embolus arising in the left femoral vein. The peritoneal cavity had completely recovered.

The only severe postoperative complication which occurred in this series was a subphrenic abscess, followed by an empyema. In this patient two drains were inserted, one suprapubic and one in the flank. Is it not conceivable that the additional trauma attendant upon the insertion of these drains might have been the factor which broke down the inflammatory barrier and lowered the patient's resistance to the infection? Among the members of our division, I was the last to refute the idea that drainage of the peritoneal cavity was an asset. This series has convinced me of its futility. In future I shall require very definite and incontrovertible evidence of gross suppuration before I would use a drain at all.

It is interesting to know the fate of these patients upon whom we have operated. In 20 there was persistence of symptoms of sufficient severity to warrant the suggestion of further operative interference. Eleven of these patients have been operated upon, 10 of them by members of our own staff. Two had removal of a gall bladder filled with stones. It was one of these patients who was operated upon elsewhere. In the case of associated cholelithiasis which we had the opportunity of operating upon, this procedure was carried out by Dr. R. I. Harris, and with the abdomen open there was no gross sign of a duodenal ulcer present. Four patients were submitted to partial gastrectomy, and 4 to gastro-enterostomy. There was no operative death in any of these secondary procedures. We have thus carried 51 patients through the catastrophe of an acute perforation of a duodenal ulcer with a single fatality, this patient dying from a massive pulmonary embolus on the twelfth postoperative day. Eleven of these patients have submitted to secondary operations of an elective character, without a fatality. The only other patient in the group who is dead as a result of the original disease was one of the 2 patients upon whom a gastro-enterostomy was done coincident with closure of the perforation. He died of a perforated jejunal ulcer, despite our efforts to close it, 6 months after the operation to deal with the perforated duodenal ulcer. It was my misfortune to operate upon this patient on both occasions, and it was this experience which led us to abandon any but the most simple procedure designed solely to save life in patients suffering from an acute perforation of a duodenal ulcer.

## SUMMARY AND CONCLUSIONS

A series of 51 consecutive perforated duodenal ulcers is presented, operated upon with a single primary mortality. The only ultimate fatality resulted, 6 months later, from a perforated jejunal ulcer in a patient who had a gastro-enterostomy coincident with the closure of his perforation.

Eleven patients submitted to elective secondary operations without a fatality. Six still have symptoms from original duodenal ulcer sufficiently severe to warrant further operative interference.

In only 11 of 46 cases in which drainage was mentioned, was drainage established.

Of 30 cultures taken, 20 were sterile. The only pathogenic organism recovered in the 10 positive cultures was a pure culture of Bacillus typhosus which was found in 1 case.

The only severe complication in the series, apart from the fatal embolus, namely a subphrenic abscess and empyema, occurred in a patient in whom two drains were inserted.

Supportive measures, directed to the correction of the associated biochemical upset, before operative interference, justify the time consumed.

Three interrupted sutures tied over a free omental graft is all that is necessary effectively to close the perforation and save patient's life.

Routine drainage would appear to be not only of doubtful value, but even harmful.

If, as is so often advocated, a routine gastro-enterostomy had been carried out, there would have been 32 patients in this group, at present symtom-free, who would have had an unnecessary gastro-enterostomy, with its potential dangers, as in 25 cases in which a postoperative gastric test meal was done, the average number of clinical units of free hydrochloric acid was 50.

The results support the principle that in acute intraperitoneal emergencies, the biochemical upset should first be corrected, prior to the most simple operative procedure, designed only to save life, and directed solely to the lesion creating the emergency.

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# SURVEY OF APPENDICITIS IN SAN DIEGO

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INTEREST in this subject was developed by a desire to compare statistics in San Diego with numerous similar studies made in cities and institutions throughout the country. We feel apologetic about presenting another such review except for the fact that the lessons taught by previous studies are not generally known or accepted by many in the profession. Only by repeated emphasis and comparison of the significant facts presented by these widely diversified analyses may we reasonably expect to crystallize opinion for proved practices in management and treatment.

## MORTALITY

The annual mortality from appendicitis in the United States is approximately 20,000. The average mortality rate per 100,000 population for the United States is 14.2; for San Diego it is 13.0.

Table I shows the general distribution of 3,526 cases in 4 hospitals in San Diego for the 10 year period 1924 to 1933 inclusive. The deaths during this period in the 4 institutions listed were 142, from all other sources 126, making a total mortality of 268.

A survey of published statistics reveals a wide variation in mortality rates depending upon the methods of classification, the types of cases, and variations in treatment. Mortality rates based upon vital statistics show a universal increase in the past 20 years. Also, published reports from reliable sources show a universal increase in the incidence of operations for appendicitis, undoubtedly on the basis of better scientific knowledge and diagnostic skill. These same articles show a decreased operative mortality of from 2 to 6 per cent.

We may therefore conclude that the mortality rate in appendicitis, based on vital statistics, has been gradually rising while the mortality based upon operations for appendicitis has been gradually falling. Notwithstanding this improvement, I think we will all agree that further reduction of mortality may be had by educating the public to seek medical advice for any type of abdominal pain and discourage self and drug store medication. Further reduction can most certainly be had by emphatically discouraging any medical treatment of appendicitis by morphine, cathartics, or ice bags and reducing the mistakes in diagnosis by better knowledge of the symptomatology and differential diagnosis. Finally, there are other important causes of mortality which must be charged directly to the surgeon; such as, wrong type of operation performed at the wrong time, and more particularly, the improper treatment of general peritonitis. Familiarizing ourselves with the facts regarding these points, as brought out by analysis of large numbers of cases, will do much in self education and help reduce the mortality in this disease.

## CRITICAL ANALYSIS OF 1,031 CASES AND COMPARISON OF MORTALITY

Table II shows the distribution of 1,031 cases at the San Diego County Hospital and the Scripps Memorial Hospital as regards pathological type and resulting mortality.

There were 353 non-acute cases at the County Hospital with a mortality of 1.1 per cent, 119 cases at the Scripps Hospital with no mortality. Percentage mortality for this group was arrived at by averaging the results of Reid, Hobler, and Keyes, in their recent reports on 3,203 chronic cases which showed 0.5 per cent mortality. The series of these same authors, with the addition of Pattison's cases, makes a total of 9,566 acute cases with 462 deaths, or an average mortality in acute unruptured cases of 0.55 per cent, ruptured with abscess and local peritonitis of 9.0 per cent, and ruptured with general peritonitis of 30.5 per cent, with an average mortality for all acute cases of 4.8 per cent. In our comparison, the mortality for acute unruptured appendicitis was 1.3 per cent at County and 2.1 per cent at Scripps; 15.5 and 12.5 per cent, respectively, for ruptured with abscess and local peritonitis, and 17.4 and 19.3 per cent for cases with ruptured appendicitis with general peritonitis. The first two groups show a considerably higher mortality in this survey, while the cases with general peritonitis shows a very considerable reduction compared with their average mortality for this group. The general average mortality for all acute cases of 7.1 per cent at the County and 9.4 per cent at Scripps is again higher than the combined average for their series of 4.8 per cent. A further comparison may be had by referring to Table III

TABLE I.—GENERAL DISTRIBUTION APPENDICITIS CASES SAN DIEGO CITY AND COUNTY

| Hospital | Cases | Deaths | Period in years | Mortality per cent |
|---|---|---|---|---|
| County | 827 | 38 | 10 | 4.6 |
| Mercy | 2,386 | 93 | 10 | 3.8 |
| San Diego | 109 | 3 | 5 | 2.7 |
| Scripps | 204 | 8 | 8 | 3.8 |
| Totals | 3,526 | 142 | | 4.0 |
| All other institutions | unknown | 126 | 10 | |

Mortality rate per 100,000 population in San Diego, 13.0; mortality rate per 100,000 population in United States, 14.2. Total deaths from appendicitis, city and county, 1924 to 1933 inclusive, 268.

where an average mortality of 5.4 per cent in 19,615 reported acute cases from 11 authors is listed. It will be seen, our figures compare favorably with several in the higher brackets, but the average mortality remains a challenge to the profession in San Diego. An average mortality for all cases of 2.9 per cent for 6,019 listed by two authors is approximately 1 per cent better than our figures.

Table IV with the accompanying graph, shows that in only 12 per cent of the cases studied patients came to operation prior to 18 hours after the onset of symptoms. This group was taken from the County Hospital where the incidence of delay is greater because of the class of people served and where self medication is most prevalent. In most instances, the physician was called after the attack had been in progress for hours, or days, and therefore these figures are not an indictment of the medical profession. Delay as a prime factor of the increase in mortality has been repeatedly shown in all sections of the country. The results of education of the public in this regard have been very clearly shown by Bower in reduction of the time from onset of symptoms to operation with a notable mortality reduction.

The graph further demonstrates the periods of greatest mortality, particularly the sharp rise in the period of 24 to 36 hours after onset of symptoms. The mortality within the first 24 hours is approximately 2 per cent in this series, rising rapidly to over 10 per cent in the 6 hour period between 24 and 30 hours which is the period of rupture and associated shock. The mortality falls again in the next period from 30 to 72 hours, and then rises rapidly from 72 to 120 hours, which is the period of abscess formation and general peritonitis.

At this point, a discussion of some of the factors responsible for the high mortality in the 24

TABLE II.—CRITICAL ANALYSIS OF 1031 CASES

| Type of case | County | | | Scripps | | | Average from recent literature | |
|---|---|---|---|---|---|---|---|---|
| | Cases | Deaths | Mortality per cent | Cases | Deaths | Mortality per cent | Cases | Mortality per cent |
| Chronic | 276 | 3 | 1.0 | 87 | 0 | 0 | | |
| Subacute | 77 | 1 | 1.3 | 32 | 0 | 0 | | |
| Totals | 353 | 4 | 1.1 | 119 | 0 | 0 | 3203 | 0.5 |
| Acute unruptured | 297 | 4 | 1.3 | 46 | 1 | 2.1 | | 0.55 |
| Ruptured with abscess | 45 | 7 | 15.5 | 8 | 1 | 12.5 | | 9.0 |
| Ruptured with peritonitis | 132 | 23 | 17.4 | 31 | 6 | 19.3 | | 30.5 |
| Totals | 474 | 34 | 7.1 | 85 | 8 | 9.4 | 9566 | 4.8 |
| Grand totals | 827 | 38 | 4.6 | 204 | 8 | 3.8 | | |

to 36 hour period, before general peritonitis has developed, is pertinent. I believe it has been the accepted teaching in the past that once a diagnosis of acute appendicitis or its immediate complications of abscess or localized peritonitis has been made, immediate operation should be performed. This is undoubtedly correct in the acute stage if the patient is seen within the first 24 hours before complications take place, and his condition is good. But there is serious doubt as to the advisability of immediate operation in the period of greatest reaction to the infection, or when rupture has possibly occurred and shock is present and the patient dehydrated from vomiting. Operation under these conditions is admittedly poor surgery and particularly in the presence of a localizing or localized abscess. Emergency operation on a poor risk is a deciding factor in converting a localizing infection to a generalized one. These patients usually enter the hospital with high fever and a rapid pulse. With bed rest and intravenous fluids the fever subsides and the pulse rate slows down with consequent improvement of the general condition. Depending on the signs, symptoms, and reaction of the patient, operation may be delayed 6 to 12 hours or longer in the presence of a localizing abscess until the abscess is more clearly defined. Arnheim reported a mortality of 8.2 per cent at the Mount Sinai Hospital, New York City, for the years 1928, 1929, and 1930 for all acute cases. This was reduced to 2.8 per cent for the following 3 years in the same class of patient merely by instituting supportive measures and delaying immediate operation on acutely ill patients in the second day period until the general condition of the patient

improved, or better, localization of the inflammatory process had taken place. In his first series, immediate operation on cases with abscess formation showed a mortality of 21.2 per cent, this being reduced in the second series to 6.4 per cent. In Arnheim's report, critically ill patients with diffuse peritonitis were not operated upon immediately on admission to the hospital. They are given absolute rest, morphine, and intravenous glucose and saline for several hours until there is definite improvement in the patients' condition. By this routine, mortality was reduced from 21.4 per cent in the first series, to 16.6 per cent in the second.

Most reports agree that one exception to the above should be observed, and that in the case of children, where the pathological process is fulminating and for anatomical reasons poorly walled off, and diagnosis difficult. Misuse of cathartics is nearly always present so that immediate operation should be done, administering necessary fluids immediately before and during operation.

Someone has coined the dictum "too late for early surgery, too early for late surgery" to the high case fatality around the 24 hour period.

Table V shows the number of ruptured cases to acute cases with mortality by years at the County and Scripps Hospitals. These data merely emphasize what similar studies have shown, namely, that the greatest incidence is in the second and third decades, 65 per cent of all cases occurring in these years at County. Also, the high percentage of ruptured cases, 56.1 in the first 10 years of life, with an average of 57.1 from 40 to 80 years of age in this same series. The mortality for children was 9.7 per cent with a progressively mounting mortality for the later years of life. The cases at Scripps, although small in number, show approximately the same percentage for rupture at the various age periods, but with a much better mortality record.

Some of the reasons for this higher mortality in the early years have been noted above. Local infection of the lymphoid tissue predominates in the pathological progress in the earlier years of life, which is fundamentally suppurative with perforation and abscess formation the usual sequelæ; when gangrene occurs, it is first of the patchy variety and only later involves the whole organ. In the older subject, on the other hand, lymphoid tissue has more or less disappeared and appendicitis is fundamentally a vascular disease. The vascular factor predominates, the primary pathological change tends to be a massive gangrene. The circulation of the appendix, which is terminal, lends itself peculiarly well to this sort of pathology. The consequences of the disease are, therefore, entirely different. In young subjects, the disease tends to localize; in old subjects, it tends to spread. Because of the vascular factor in the latter instance, the infection goes on to mesenteric thrombosis and pylephlebitis. Furthermore, the early clinical course is usually atypical, accounting for late diagnosis and deferred operation with the high mortality shown.

TABLE III.—COMPILED STATISTICS SHOWING MORTALITY IN APPENDICITIS

Acute cases

| Year reported | Years studied | Cases | Mortality per cent | Author |
|---|---|---|---|---|
| 1928 | Not stated | 675 | 5.3 | Eliason and Ferguson |
| 1928 | 1921–1926 | 435 | 7.5 | Hage, A. F. |
| 1928 | 1919–1927 | 1,000 | 2.7 | Quain, E. P. |
| 1930 | 1928–1929 | 5,121 | 5.9 | Bower, J. O. |
| 1930 | 1924–1927 | 2,415 | .99 | Miller, C. J. |
| 1931 | 1930 | 3,095 | 4.8 | Bower, J. O. |
| 1931 | Not stated | 141 | 7.1 | Miller, E. L. |
| 1931 | 1926–1930 | 1,574 | 4.5 | McDonald, A. L. |
| 1931 | Not stated | 361 | 6.4 | Tasche and Spano |
| 1932 | 1928–31 | 528 | 1.5 | Dixon, C. F. |
| 1932 | 1927–1931 | 4,270 | 4.4 | Boland, F. K. |
| | Total | 19,615 | 5.4 | |

All cases

| | | | | |
|---|---|---|---|---|
| 1934 | 1927–1930 | 2,106 | 3.5 | Walker, I. |
| 1933 | 1900–1930 | 3,913 | 2.3 | Finney, J. M. T., Jr. |
| | Total | 6,019 | 2.9 | |

According to our statistics, about 35 per cent of cases with acute symptoms at both County and Scripps received cathartics, which is low compared to other reports and no doubt is due to the inaccuracy of the histories. Finney reported patients receiving cathartics in 40 per cent of acute unruptured cases and in 60 per cent of ruptured cases. In Philadelphia, Bower reports that when a cathartic was not given, 1 case in 57 died. When one cathartic was taken, 1 in 18 died, and when more than one carthartic was administered 1 in 9 died. These figures leave no doubt of the importance of this factor in mortality production.

Table VI shows comparative blood counts of cases at the County, Scripps, and Finney's Series. The average polymorphonuclear count in Finney's cases was 67 per cent for chronic, 84 per cent for acute unruptured and ruptured with abscess, and 87 per cent for ruptured with general peritonitis. The last year we have been using the Schilling differential blood count and feel it is a more

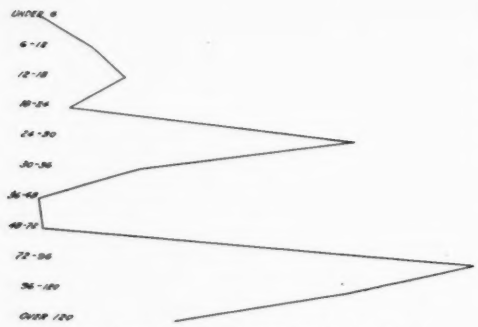


Fig. 1. Graph of results as shown in Table IV.

accurate index of the degree of the inflammatory process than the routine count employed in the past.

Table VII shows the type of anesthesia used at County and Scripps. In no instance was there a fatality due to the anesthetic in either series. It is to be noted that approximately twice as many patients received spinal anesthesia at Scripps as on the County Service. This is undoubtedly a reflection of the individual preference of the operating surgeon. It is our personal belief that if there is no contra-indication to spinal anesthesia, it is the anesthetic of choice in these cases; particularly patients with rupture, abscess, or peritonitis. Time does not permit a discussion of the advantages of spinal anesthesia. We feel that in selected cases it is safe, with proper technique of dosage and administration. The importance of a quietly administered anesthetic to prevent breaking down of walled off purulent exudates, and the contraction of the intestines, makes possible accurate and careful surgery in the removal of the appendix with the minimum of trauma. Many authors have stressed this point and remarked on reduction in mortality by its use. Loveland in a recent article attributes a mortality reduction of 4.3 per cent to 1.9 per cent in a comparable series of cases to the use of spinal anesthesia as this was the only variable factor in management.

Table VIII shows the type of incision employed and the percentage of drainage in unruptured cases, also the number of cases in which drainage was employed without appendectomy. In four-fifths of the cases in both series, the right rectus incision was used. The comparatively infrequent use of the McBurney incision is difficult to explain in view of the consensus in its favor, both for uncomplicated and complicated cases. For example, Reid recently reported a decrease in mortality of 50.3 per cent in acute appendicitis when the operative incision was changed from a rectus to a McBurney. Likewise, Pattison in reporting a comparative series of cases of acute appendicitis showed the mortality in similar cases with the rectus incision to be 6.4 per cent while with the McBurney incision it was reduced to 0.6 per cent.

The arguments in favor of the McBurney incision may be cited as follows:

1. It gives direct approach with minimum trauma and contamination of the general peritoneal cavity.

2. Abdominal drainage through this incision is the shortest and most direct.

3. Statistics show fewer postoperative ventral hernias following drained suppurative McBurney wounds than with any other type of infected laparotomy incisions.

4. Secondary operations for intestinal obstruction, etc., if necessary are facilitated by the suppurating wound being in the right lower quadrant and away from the newly contemplated laparotomy wound.

5. Patients become ambulatory sooner. Numerous authors report differences of from 3 to 5 days.

6. A general exploratory incision is seldom needed for such limited and localized pathology.

Arguments against the McBurney incision are chiefly those associated with limited exposure. Arguments in favor of the right rectus incision are principally adequate exposure. Arguments against it may be listed as follows:

1. Danger of disturbing a localized abscess contaminating the general peritoneal cavity.

2. Danger of evisceration with dissolution of the wound following infection. Two deaths in this series at the County Hospital were attributed to this accident.

3. Possibility of extensive adhesions with greater tendency to obstruction when drains cross the abdominal cavity to a rectus incision.

Recent reported opinion favors no drains in acute unruptured appendicitis, even in the presence of turbid intraperitoneal fluid which, for the most part, is only a protective exudate. An exception to this rule would be the presence of gross necrotic tissue in the region of the removed appendix. In view of these expressions, the percentages listed of drainage in unruptured cases of 27.6 and 34.7 appear far too high. Lastly, Table VIII shows 23 patients, or 2.7 per cent, in which drainage alone was instituted without removing the appendix. Two deaths occurred in these cases both with general peritonitis and not localized abscess.

TABLE IV.—DURATION (HOURS) ATTACK BEFORE OPERATION WITH MORTALITY (COUNTY)

| Type of case | Under 6 hrs. | 6–12 hrs. | 12–18 hrs. | 18–24 hrs. | 24–30 hrs. | 30–36 hrs. | 36–48 hrs. | 48–72 hrs. | 72–96 hrs. | 96–120 hrs. | Over 120 hrs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chronic | 5 | 12 | 6 | 16 | 6 | 7 | 13 | 19 | 22 | 22 | 97 |
| Subacute | 0 | 2 | 2 | 1 | 1 | 0 | 5 | 6 | 7 | 5 | 39 |
| Acute unruptured | 3 | 29 | 24 | 52 | 20 | 15 | 33 | 24 | 19 | 17 | 48 |
| Ruptured with abscess | 0 | 1 | 0 | 5 | 0 | 1 | 2 | 5 | 8 | 4 | 15 |
| Ruptured with peritonitis | 0 | 9 | 2 | 15 | 11 | 7 | 24 | 27 | 13 | 5 | 15 |
| Total cases | 8 | 53 | 34 | 89 | 38 | 30 | 77 | 81 | 69 | 53 | 214 |
| Deaths | 0 | 1 | 1 | 1 | 4 | 1 | 0 | 5 | 10 | 5 | 10 |
| Mortality per cent | 0 | 1.8 | 2.9 | 1.1 | 10.5 | 3.3 | 0 | 6.1 | 14.5 | 9.4 | 4.6 |

Table IX is a comparison of the mortality rate for internes and resident surgeons, and the visiting staff at County. A mortality of 0.57 per cent in chronic cases by the visiting staff is average but 2.0 per cent mortality for this group by the house staff is rather high. The figures for acute cases are more in line with other similar comparisons. For example: In Walker's series the total mortality for residents and internes was 4.5 per cent from 1907 to 1910 which was reduced to 2.9 per cent from 1927 to 1930, with many more cases coming to operation in the latter period. In Finney's series, mortality rates were comparable for all grades except abscess and general peritonitis which were considerably higher for the house staff. Our 100 per cent increase in mortality of resident over visiting surgeons is out of line with similar reports. As a matter of fact, the surgical staff at County Hospital has been enlarged and co-ordinated to permit a better supervision of the work, which will undoubtedly show an improvement in these statistics in the future.

TABLE VI.—AVERAGE TOTAL LEUCOCYTE COUNT

| Type of case | County | | Scripps | | Finney's series Baltimore | |
|---|---|---|---|---|---|---|
| | Cases | Total count | Cases | Total count | Cases | Total count |
| Chronic | 254 | 10,500 | 59 | 9,300 | 103 | 9,017 |
| Subacute | 66 | 10,800 | 25 | 11,600 | 399 | 10,876 |
| Acute unruptured | 297 | 14,400 | 40 | 15,600 | 785 | 16,361 |
| Ruptured with abscess | 37 | 21,100 | 7 | 19,200 | 233 | 18,696 |
| Ruptured with peritonitis | 104 | 16,300 | 27 | 13,700 | 144 | 17,951 |

TABLE V.—NUMBER OF RUPTURED CASES TO ACUTE CASES WITH MORTALITY BY YEARS

| Year period | County | | | | | Scripps | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acute cases | Ruptured cases | Per cent | Deaths | Mortality per cent | Acute cases | Ruptured cases | Per cent | Deaths | Mortality per cent |
| 0–10 | 41 | 23 | 56.1 | 4 | 9.7 | 9 | 2 | 22.2 | 0 | 0 |
| 10–20 | 179 | 58 | 32.4 | 10 | 5.5 | 30 | 8 | 26.6 | 1 | 3.3 |
| 20–30 | 170 | 33 | 19.4 | 7 | 4.1 | 24 | 4 | 16.6 | 1 | 4.1 |
| 30–40 | 71 | 20 | 28.1 | 5 | 7.0 | 15 | 6 | 40.0 | 1 | 6.6 |
| 40–50 | 29 | 15 | 51.7 | 2 | 6.9 | 13 | 3 | 23.0 | 0 | 0 |
| 50–60 | 29 | 16 | 55.5 | 4 | 13.8 | 14 | 8 | 57.1 | 1 | 7.1 |
| 60–70 | 14 | 10 | 71.4 | 4 | 28.5 | 6 | 4 | 66.6 | 2 | 33.3 |
| 70–80 | 2 | 1 | 50.0 | 2 | 100.0 | 3 | 3 | 100.0 | 2 | 66.6 |

Of the 38 deaths at County and 8 at Scripps, over 98 per cent were due to general peritonitis or some complication produced by the latter. Although little progress has been made in mortality reduction of general peritonitis, the lethal factors and accepted practices in its treatment may be stated as follows:

1. Dehydration with associated hypochloridemia.
2. Intoxication from stagnant contents of paralytic intestinal loops, proteose in nature.
3. Shock incident to dehydration and zero splanchnic tone caused by proteose intoxication.

In the matter of therapy, first consideration should be given to the removal of the focus of infection in patients who have been made reasonably safe operative risks by the usual means, such as, blood transfusions, fluids, etc. After operation the value of large doses of opiates is well established. Maintenance of the proper water balance to combat dehydration and hypochloridemia by means of glucose and saline solutions intravenously and by hypodermoclysis is essential. The intoxication, both proteose and bacterial, may best be combated by maintenance of fluid balance, use of indwelling Levine tube with continuous suction, occasionally supplemented by enterostomy in selected cases, continuous use of pitressin to maintain splanchnic tone and control ileus, and blood

TABLE VII.—ANESTHETIC

| | County | | Scripps | |
|---|---|---|---|---|
| | No. | Per cent | No. | Per cent |
| Gas, oxygen, ether. . . . | 314 | 37.9 | 49 | 24 |
| Ether. . . . . | 305 | 36.8 | 61 | 29.9 |
| Spinal. . . . . | 100 | 12.0 | 45 | 22.0 |
| Nitrous oxide. . . . . | 8 | 0.9 | 5 | 2.4 |
| Ethylene. . . . . | 98 | 11.8 | 48 | 23.5 |
| Local novocain. . . . . | 2 | 0.2 | | |
| Avertin. . . . . | | | 1 | 0.4 |

TABLE VIII.—INCISION AND DRAINS

| | County | | Scripps | |
|---|---|---|---|---|
| | No. | Per cent | No. | Per cent |
| McBurney | 163 | 19.7 | 36 | 17.6 |
| Right rectus | 561 | 67.8 | 154 | 75.4 |
| Midline | 103 | 12.4 | 14 | 6.8 |
| Drains in acute unruptured cases | 82 | 27.6 | 16 | 40.0 |
| Drainage without appendectomy* | 23 | 2.7 | | |

*Deaths, 2; mortality per cent, 5.3.

transfusion. Finally, the close association of the anaerobic group of bacteria with these infections justifies prophylactic use of antitoxin in all cases. Several reports testify to the not infrequent beneficial results from this therapy.

## SUMMARY AND CONCLUSION

1. The annual mortality from appendicitis in the United States is approximately 20,000. The mortality rate per 100,000 population in the United States is 14.2, in San Diego 13.0. While vital statistics show an increasing mortality rate, statistics for operative mortality are gradually falling.

2. The average mortality for operations on chronic appendicitis is 0.5 per cent, in our series in San Diego mortality for this group was 1.0 per cent. The average mortality for all acute cases is 5.0 per cent, in our survey 8.2 per cent. The average mortality for all cases is 3.0 to 4.0 per cent, in our series it was 4.0 per cent.

3. Only 12.0 per cent of our series came to operation in the first 18 hours. Further delay increases mortality from 2 to 15.0 per cent.

4. Immediate operation in unruptured appendices during the period of shock, dehydration, and early localization of the infection is poor surgery and materially increases mortality.

5. The high mortality and high percentage of ruptured cases in childhood and after 40 years of age is demonstrated, and the probable reasons are discussed.

TABLE IX.—COMPARISON OF INTERNES' AND RESIDENT SURGEONS' AND VISITING SURGEONS' MORTALITY

| Type of case | Visiting surgeons | | | House surgeons | | |
|---|---|---|---|---|---|---|
| | Operated upon | Deaths | Mortality per cent | Operated upon | Deaths | Mortality per cent |
| Chronic | 175 | 1 | 0.57 | 101 | 2 | 2.0 |
| Subacute | 54 | 0 | 0.0 | 23 | 1 | 4.3 |
| Acute unruptured | 141 | 2 | 1.3 | 156 | 2 | 1.5 |
| Ruptured with abscess | 19 | 3 | 15.8 | 25 | 4 | 16.0 |
| Ruptured with peritonitis | 66 | 10 | 15.1 | 61 | 13 | 21.3 |
| Totals | 455 | 16 | 3.5 | 366 | 22 | 6.0 |

6. The lethal effects of cathartics are reemphasized.

7. Factors in mortality reduction as regards surgical management are discussed, including time and type of operation, choice of incision, drainage, anesthesia, and factors in the treatment of general peritonitis.

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# EDITORIALS

SURGERY
Gynecology and Obstetrics

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FEBRUARY, 1937

## SHOCK

IT HAS been the custom to divide cases of shock into primary and secondary types, depending on the rapidity with which the condition develops after the receipt of the injury. There is much to be said against such a classification. The terms were introduced in the 1870's but were abandoned, only to reappear in the literature of the Great War period, when the theory of traumatic toxemia was also revived. A state of traumatic shock may follow directly the receipt of an injury and there may be no intermission in the symptoms until the syndrome is terminated by recovery or death. It is obviously unwise under such circumstances to classify the condition according to the time separating the injury and the decline in blood pressure. The adoption of a classification which has an etiological basis is quite desirable.

It has been suggested that the terms hematogenic, neurogenic, and vasogenic be used in designating different types of shock. Hematogenic refers to the instances in which there is a decrease in the blood volume as a result of hemorrhage or dehydration or the loss of whole blood or plasma into or from an injured area. The condition which results from uncomplicated hemorrhage or from trauma to large masses of muscle is an example of this class. By the neurogenic type is meant the vasodilatation which is dependent on diminished constrictor tone as a result of influences acting through the nervous system. There may be a loss of central control of vascular tone in minor injuries and in emotional disturbances. Neurogenic shock may be brought about by agencies which influence the nervous system directly, such as spinal anesthesia or trauma, or it may be reflex in origin as for example the collapse that follows a severe blow on the abdomen. The vasogenic type refers to the condition in which there is a loss of peripheral vascular tone caused by agencies which act directly on the blood vessels. Histamine probably exerts the major portion of its effect in this manner.

There is little doubt but that such a classification is more scientific than the division into primary and secondary types, but at best it is not entirely satisfactory. There are many conditions which cannot be placed in any single one of these types but are rather a combination of all of them. Many different factors may enter into the production of shock that is associated with operations. Among these may be included hemorrhage, loss of plasma from exposed surfaces, loss of water by sweating, dilatation of vessels as a result of mechanical irritation and vascular reflexes, infection, anesthesia and particularly the disease for which the operation is performed.

Fully developed shock is often so complicated that it is impossible to separate the different factors which have played a part in its production. This is not usually true in the early stages. It is upon the prompt recognition of the type of shock that the proper mode of treatment depends. For example, the immediate decline in blood pressure which may be associated with the opening of the peritoneal cavity is neurogenic in origin and will likely disappear if the operative procedure is terminated or if a vasoconstrictor drug is injected. Even when the blood pressure remains at a low level for a considerable time under such conditions, it is usually not a matter of grave concern since the total blood volume is not greatly reduced and there is not a serious deficit in the supply of oxygen to vital structures. A similar fall in blood pressure in hematogenic shock, such as follows the crushing of large masses of muscle, should be a matter of great concern. The volume of circulating blood is greatly reduced under such conditions and therapy should consist of replacing the lost volume of blood rather than employing drugs which increase the already existing vasoconstriction.

It is in regard to the explanation of the hematogenic type, usually termed secondary shock, that most of the theories have been advanced. A number of workers in America have found that the decline in blood pressure following trauma to large masses of muscle is due to the decrease in blood volume resulting from the loss of red blood cells and plasma into and near the injured area. Capillary congestion and dilatation throughout the body does not take place until the blood pressure has remained at a low level for an extended period. These findings have been confirmed in England by Holt. O'Shaughnessy and Slome, also of England, agree that the local loss of fluid is the main initiating factor in the production of shock following trauma to muscles but believe that it is necessary to add a neurogenic factor as well. They found that continuous spinal anesthesia increased the resistance of animals to trauma. Although Holt has not been able to confirm these results, they contain important findings and cannot be dismissed lightly.

Freeman has pointed out that many of the factors in the production of shock have one action in common and that is to stimulate the sympatho-adrenal system. He found that the injection of adrenalin in physiological amounts reduces the blood volume. Gregersen and Pinkston have been unable to confirm his results. Vasoconstriction is normally a protective mechanism and it is difficult to believe it to be an important initiating factor in the causation of shock. It delays the decline in blood pressure following hemorrhage by diminishing the caliber of the vessels. On the opposite extreme, Swingle and his associates have reported that deficiency of the adrenal cortical hormone results in increased permeability of capillaries and loss of plasma with blood concentration and serious reduction in circulating blood volume. They assume that this plays a rôle in surgical shock but proof of this view is lacking.

No convincing evidence has been brought forward in recent years to support the view that shock following trauma is due to the absorption of histamine. Roome and Wilson found that extracts from traumatized muscle usually caused a rise in blood pressure when injected into dogs which had received heparin. Sir Henry Dale recently stated, "With regard to the possible rôle of histamine, we know now, what we did not know then, that of all the major tissues of the body, the muscles contain least of that substance. Whatever else it may have been, the shock following the Bayliss-Cannon limb trauma was not histamine poi-

soning." However, this does not mean that there has been ruled out the possibility of the absorption from injured tissues of substances which act very slowly and over a long period of time. Certainly it is believed rather generally that deaths which occur a number of days following burns are probably due in the main to the actions of toxic products.

The important point seems to be that the mechanism of the production of all types of shock is not the same, and they cannot all be satisfactorily explained by one theory. Less confusion will result if such attempts are abandoned. ALFRED BLALOCK.

## THE CHANGING MORTALITY OF UROLOGIC SURGERY

THE story of the greater accuracy of diagnosis, of the progress in treatment, and of the constantly decreasing mortality in urologic surgery parallels the progress of surgery in general. Indeed it may be said, moreover, that urologic surgeons have been pioneers in extending surgical frontiers; their work has frequently suggested to the masters of general surgery the possibilities of relief by surgery in conditions previously considered non-surgical; surgery was done and proved to be satisfactory for the relief of urinary distress long before abdominal operations were attempted.

Within the past three decades the mortality resulting from operations on the urinary tract has been reduced from one death in every four operations to a very slight fraction which may be considered the mortality of unavoidable accident.

Looking at one phase of urologic surgical advance, quite a contrast in accuracy of diagnosis, technical skill, and end-results is offered between the status of 1895—when A. O. J. Kelly reported a large series of renal tumors, 72 per cent of which came to autopsy undiagnosed—and that of our present period, when most of these conditions, now recognized early, are successfully located and treated.

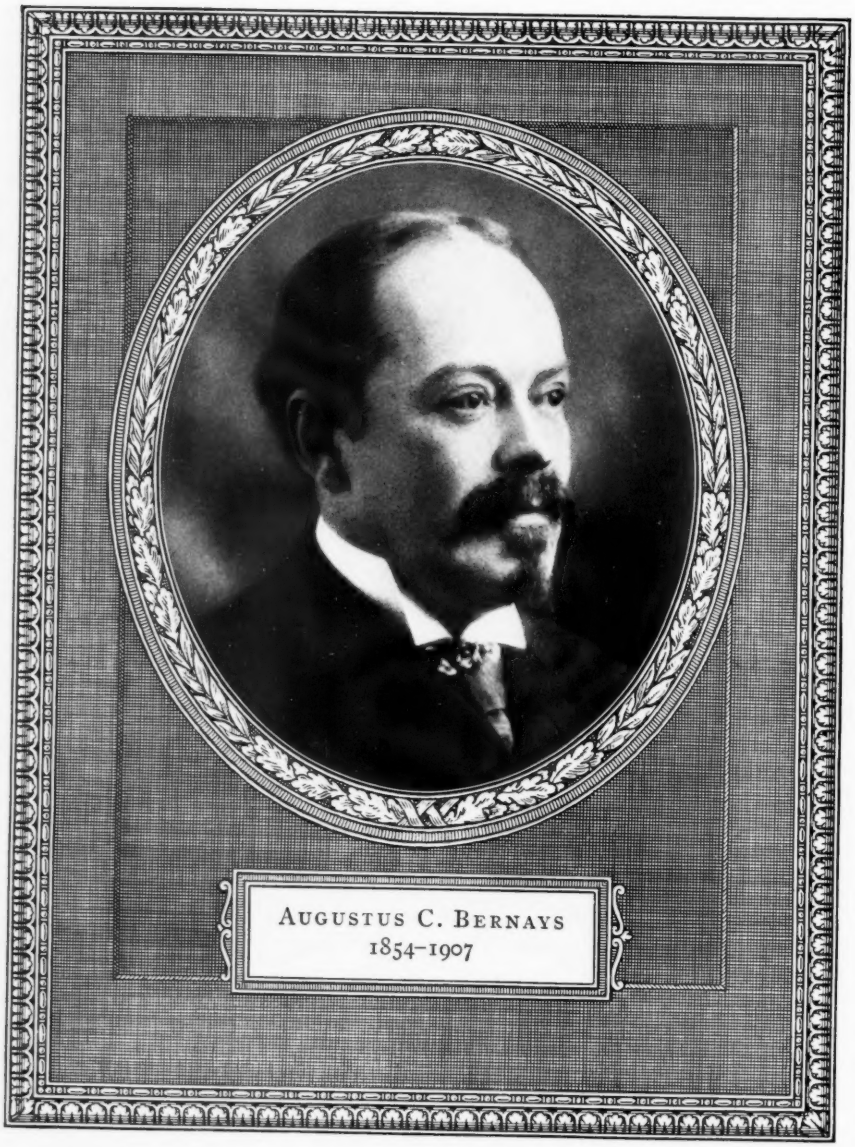
In an era of greater skill and separate from the early formative period of urologic surgery, these changes and improvements, particularly the decrease in mortality rates, have been encompassed in a surprisingly short period of time. Let us consider some of these results. Kuster, in 1902, collected and reported over 600 cases of various types of operations for kidney stones. He found a mortality of over 19 per cent. In 1914 the average mortality in reported series was 9 per cent, and ten years later mortality rates had been lowered to about 1 per cent in one series of over 1400 cases. In 1900 the mortality following nephrectomy for the cases of renal tuberculosis, of which accurate statistics were available, was over 21 per cent. By 1910 it had been lowered to about 9 per cent. These are the cases from the lists of the best known urologic surgeons of that time, the work of men such as Wildbolz, Rovsing, and Israel. The next ten years finds a drop in mortality to slightly over 2 per cent, together with a corresponding decrease in undesirable postoperative sequelæ and an improvement in the general results. Jeanbrau reported a mortality of 13 per cent in the patients with ureteral stones operated upon in the ten years prior to 1910. Fifteen years later various reports are noted with less than a 1 per cent mortality for surgical removal and no mortality at all for those cases in which the stone was removed by manipulation. Whiteside in 1905 noted a general mortality of 20 per cent in prostatectomy. A recent review of the work of 73 urologists by Orr shows an average mortality for prostatectomy of 3.8 per cent, and several large series of cases have been reported without a death. Reports on prostatic resection for relief of

prostatic troubles are also of interest. T. M. Davis removed prostatic obstructions in 966 cases by electroresection with only 0.7 per cent mortality, and Bumpus has resected over 300 prostates without a fatality.

This change in mortality is due not only to better operative technique, more rigid asepsis, and highly developed surgical skill, but primarily is attributable to improved methods of diagnostic precision. The existing disease is identified and localized to a definite division of the urinary tract. This permits a rapid surgical approach, a minimum of operative trauma, and a convalescence uncomplicated by the results of an extensive surgical exploration.

It is questionable if any other branch of surgery can show better end-results of operations accomplished in so short a period.

A. J. SCHOLL.



AUGUSTUS C. BERNAYS
1854–1907

# MASTER SURGEONS OF AMERICA

## AUGUSTUS CHARLES BERNAYS

BLESSED with a distinguished inheritance, with a most unusual mental equipment and with abundant physical vigor and afforded every opportunity for study, Augustus Charles Bernays entered the field of surgical practice.

Among his ancestors was a Bernays, Bishop of Calcutta; another, professor of chemistry at St. Thomas' Hospital; a third built the Chatham docks; one, Isaac Bernays, was consulted by Napoleon while formulating the code that still lives. Some of these early distinguished Bernays remained orthodox Jews; others were *getauft*. The parents of our own Bernays migrated from Germany to America in 1853; a year later, October 13, Augustus Charles was born at Highland, Illinois. At the early age of 12 he entered the preparatory department of McKendree College at Lebanon, Illinois, where his next 6 years, 4 of them in the college, were spent. His graduation thesis was on the "Darwinian Theory," a very early outcropping, it seems, of the interest in natural sciences later to mold his career.

He entered Heidelberg at the age of 18 where he completed the course in medicine. There he came under the dominating influence of Gegenbauer, professor of anatomy, one of that early group inspired by Virchow at Wurzburg in the early fifties. The youthful Bernays was student and later assistant of the distinguished surgeon, Simon, being the first American to receive *summa cum laude* when he finished at Heidelberg shortly after his twenty-second birthday. He then spent the winter semester of 1876 with von Langenbeck, in Berlin, and the following summer semester remained at Vienna with Billroth. He then went to London to observe the work of Sir Joseph Lister and others; while there he passed the examinations for M.R.C.S. He was occasionally entertained at the Huxley home where he was thrilled by meeting and talking with Sir Charles Darwin. A few months after his twenty-third birthday he entered the private practice of surgery in St. Louis.

He had entered Heidelberg only about 30 years after the Germans under Virchow's lead had initiated that epoch in surgery based on pathology. It had been only 12 years since Lister did that first operation of the antiseptic era; but a few months had elapsed since von Bergmann, whom he came to know extremely well, had introduced bichloride of mercury as more efficient than carbolic acid

(9 years more were to elapse before von Bergmann's steam sterilization was to replace chemicals and initiate asepsis). Furthermore he had been in practice only a few years when physiology became a fundamental to all surgical considerations; thus the stage was set for a resourceful young man in a changing era by Virchow, Lister, von Bergmann, Koch, and the others known to him personally.

He left his own mark on German medical science while under Gegenbauer's influence by producing at least three pieces of research work which anatomists say are considered fundamental to our knowledge of heart, joint, and thyroid development. I never realized how well known he was abroad until in the middle nineties Hertwig, the embryologist, said to me in Berlin, "You have certainly had a distinguished teacher in America; we consider Bernays' work on the heart and knee joint epoch-marking." That same year I asked von Bergmann, whose clinic I was attending, if he remembered Dr. Bernays of St. Louis; his rejoinder was, "Er ist mein lieber Freund." He seems to have reached the zenith of his fame abroad at the time of the International Congress at Berlin in 1890 where he read a paper, "Gunshot Wounds of the Abdomen," which was so well received that he was elected secretary of the surgical section.

He was 38 years old when I became his student, so I knew the last 15 years only of a life that was picturesque, useful, and stimulating to a superlative degree. Yearly trips to Europe had then kept him in such intimate contact with current developments in surgery that he was already working under the influence of physiology in his field.

In his late thirties and early forties his rapidly spreading reputation as a surgeon of unusual promise was based largely upon his ability as a brilliant, resourceful, and successful *operator*, the most difficult procedures being carried out without sacrifice of detail in an unbelievably short time. No local or regional anesthetic was available to warrant time-consuming operations; he used chloroform and naturally tried to cut down the dose and conserve the patient's resources by living up to the von Langenbeck inheritance from his student days when an operator had to be dexterous and a time-saver to get worth while results.

Versatility was one of his distinguished characteristics as shown by equal facility in the performance of the following: the Italian nose reconstruction, resection of all three branches of the trigeminal nerve, total resection of the mandible, complete amputation of the tongue, thyroidectomy, total excision of neck glands, gastrectomy, vaginal hysterectomy, resection of knee and elbow; while his reputation seems to have been made for those dependent upon current literature by such publications as this,[1] "Gastrotomy for the Removal of Swallowed Knife; recovery of the patient." Interest in him must have been vastly stimulated in 1888 by the publication of the first successful operation west of the Mississippi for bullet wounds of the intestine (its effect was certainly not lessened by St.

[1] St. Louis M. & S. J., VII, 9, 1887.

Louis voting the operator five hundred dollars for saving the life of the patient, a police officer). He was writing upon successful pylorectomy as early as 1887 shortly after Billroth's first successful operation of the kind; he was the first in America, too, to remove the entire stomach; he did the first cesarean section for placenta previa in 1894 and as early as 1901 was writing upon bladder drainage previous to successful prostatectomy. These and equally arresting titles appeared during the eighties and nineties under the general caption, unique as the man himself, "Chips from a Surgeon's Workshop"; indeed, his most virile years were productive of actions and ideas reflecting the fertility of an imagination handed down to him along with other oriental tendencies by a long line of Jewish ancestors on his father's side, his mother being of gentile birth.

Dr. Bernays as teacher was no less engaging than as operator or writer; he was an unconscious actor of ability—coming as he did of a race of showmen—which insured his classroom being crowded. He had had private instruction in drawing at college and his lectures in anatomy were profusely illustrated by blackboard drawings in colors made with chalk in both hands at the same time. Of course, the student was profoundly impressed by such a display as he always was when this artist did plastic work, switching flaps to a perfect fit without making a preliminary mark or indulging in any but the most cursory preparatory survey.

He was an extremist always in what he did and said, so now and then an amusing inconsistency appeared: he never failed in any lecture, no matter what the subject, to decry the use of drugs in the treatment of surgical patients, but years later when we operated upon the master himself he seemed wholly receptive then to powerful sedatives. Imagine the novelty of one lecture being punctuated by the teacher expressing his belief that no right thinking patient should submit to an operation at the hands of a man over 40; then when asked from the floor as to his own age admitting in confusion to having attained 39.

We had in our city during his best years no university medical source of authoritative opinion, hence it seemed natural for the newspapers to interview occasionally this outstanding surgeon on happenings of medical interest. This, in addition to frequent reports of his own arresting accomplishments, gave him a unique position in the public eye to the end that probably no physician of his time was known by name, if not by sight, to so many in our section of the Middle West. He was characterized by reckless optimism; he leaned a bit to the revolutionary; he detested hypocrisy; was possessed of boundless enthusiasm; was inclined to premature expression of opinion; was intolerant of commonly accepted rules of procedure; was unguarded in action and expression; was easily excitable; singularly ill-tempered, and unreasonable at the least show of incompetence in one of his team, but was equally contrite when he had cooled down and capable of a quality of generosity which is known in those who must at times compensate for a wholly unfair estimate of another's ability or character.

The vibrant Bernays, who so intrigued us in the eighties and nineties, was short of stature, stocky, dark, had a large head and prominent eyes, always in handsome clothes most carelessly worn, of most serious mien and day-dreaming when alone or unobserved, as he thought, was most approachable, affable, and genial with friends and casual acquaintances alike. His ready transition from work to play further illustrates his versatility. He was fond of night life as it existed in St. Louis 40 years ago; was a typical *bon vivant*, knowing just where to dine well; was the sort of dilettante that only a well-to-do bachelor could be; was one of our inveterate "first nighters" because of a real interest in music and the drama; was an art lover and collector as well as an artist at heart; indeed, the bachelor home which his gifted sister, Thekla, made more agreeable than a wife might have done, looked like a small public museum.

His chief diversion, if not relaxation, was found on the race track where he attended almost every "meeting" as long as the old St. Louis Fair Grounds remained open. He maintained his own racing stable where he not only bred and trained running stock but initiated all sorts of original procedures—all to no purpose—for rapidly developing his horses and increasing their speed beyond the ordinary, but in spite of occasional large winnings the losses incurred by this amateur owner practically dissipated professional earnings. Other owners, trainers, jockeys, touts, and bookies invariably played him for a "sucker" and a backer of "sure" things, still the genial Bernays grasping the spirit of all this unlike most others of his kind seems to have been tolerant through it all and to have displayed a saving sense of humor because for several years he had his racing journals, dope sheets, etc., mailed to a mythical Mr. J. Easy. Surgery was in the back of his mind even on the race track since his best known horses were dubbed The Doctor, The Surgeon, and Sir Joseph Lister. Another owner who admired him named a racer "Dr. Bernays" and our sportsman won the largest bet of his life, five thousand dollars, upon his rival's entrant, one of very few lucrative incidents to punctuate this all absorbing passion of his lighter side.

Bernays seemed particularly impressed by contacts with certain individuals while attending Congresses; one remembers vividly his returns from these excursions with expressions of admiration for C. H. Mayo, Howard Kelly, Furbringer (Gegenbauer's successor), Lawson Tate, Nicholas Senn, William T. Bull, Sir John Bland Sutton, and Harry Fenwick in particular; they always seemed to be his guiding stars.

He appeared up to the autumn of 1903 to retain his old time vigor; he surely remained extremely busy, then the handwriting on the wall became legible for even this buoyant optimist for after a camping expedition out West a slight stroke befell him; still, he made a rapid recovery and one of the heaviest professional winters of his life followed, then the summer of 1904 was spent in Japan. After a year more, being greatly improved, he wrote from the Alps that the

"stroke-like" symptoms of 2 years ago seemed to be "a thing of the past," but in January, 1906, he broke down completely and a prolonged bed rest followed during which he wrote, "The Golden Rules of Surgery"; his professional publications of all sorts having by this time amounted to one hundred eleven. In a few months he was again strong enough to travel; he and his devoted sister made the last of their European trips in the summer of that year, but during the following spring there came anginal symptoms of ever increasing intensity. May 17, 1907, was his last day outside the house; then while reading aloud to his sister 5 days later he suddenly collapsed and expired in her arms—I had the empty satisfaction of being the first from outside to reach him after he was beyond help. Just as there had been nothing commonplace in his entire career so, too, he died from a ruptured aneurism of the left ventricle; he was then not yet 54 but had surely crowded much of dramatic intensity and spectacular beneficence into that brief span. The last rites, too, were out of the ordinary, to quote from his devoted sister's, "Augustus Charles Bernays, a Memoir": "They were of my own devising. He had casually expressed the wish that friends, and not strange, hired priests, give him the last salute, and so, amidst a great concourse of those to whom the name and the form of A. C. Bernays had been the synonym of high scientific and humanitarian ideals, F. W. Lehmann, jurist, and Dr. Carl Barck, physician, loyal friends of long standing, spoke of his life and of his service with the sincerity and the simplicity that were befitting. Then his body was committed to the flames."

He was an ardent admirer of Colonel Ingersoll whom he had known personally and whose belief he shared to the end, so immortality must for him have meant the propagation of himself through that youthful group in whom his pride was centered—the Bernays school of surgeons, former assistants to whom he had striven to hand on the torch.

WILLARD BARTLETT.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE second edition of Crossen's *Gynecology for Nurses*[1] is a splendidly written text for nurses, and it is an extremely well illustrated book. The book consists of two parts:

Part 1 presents a survey of pelvic anatomy and physiology of gynecological diseases and methods employed in gynecological examination and treatment. Gynecological diseases and lesions are discussed adequately, and a portion of this chapter is devoted to a discussion of endocrine disorders. Gynecological examination and diagnosis is taken up briefly and the chapter on treatment includes non-operative measures as well as operative treatment. Some operative details are given with illustrations.

Part 2 presents the details of gynecological nursing in its various phases. Complete details of methods and preparation of supplies for use in office, dispensary, and hospital work are given. Diagrams are used freely in supplementing the text. Precise pre-operative and operative nursing duties are carefully outlined. The chapter on postoperative care in abdominal and vaginal operations is thorough and detailed. Personal psychological factors so important in good nursing care are emphasized.

The material is clearly and concisely presented and makes a very readable text; it should be an excellent text for nurses and a help to teachers instructing their pupils in gynecology and gynecological nursing.

T. J. MORRIS.

THE present volume,[2] which is the ninth of Stoeckel's monumental system of gynecology, is devoted to the glands of internal secretion. It is divided into four parts. The first deals with general information concerning endocrinology. The second considers the significance of the ovaries, the hypophysis, the placenta, and pregnancy from the point of view of internal secretions. In the third part there is a discussion of the suprarenal glands, the thyroid, the parathyroids, the thymus, the pineal gland, and the pancreas and their relation to gynecology. The last section deals with endocrine therapy in women.

The book is encyclopedic in character and contains practically all the available useful information about endocrinology in the female as known at the end of the sections early in 1935 to supply some new information. The three authors (Berblinger, Clauberg, and Kraus) are authorities in the field of endocrinology, hence the enormous array of facts presented is reliable, and the views expressed are based upon a thorough understanding of the subject.

In the section dealing with endocrinology in general, Berblinger takes up the chemistry of each endocrine gland and the interrelationships between the various glands. There is an especially interesting chapter on the relationship between the endocrines and vitamins in which the author points out both the functional and chemical similarity between these two substances. Other interesting chapters are those dealing with the changes in the endocrine glands during pregnancy and the relationship of the internal secretions to patient's constitution.

In Clauberg's section a vast amount of information is presented concerning the anatomy and physiology of the ovary and the hypophysis; also the various physiological activities and pathological disturbances of the follicular and luteal hormones and the experimental use of these hormones to produce sterility and interruption of pregnancy in animals are discussed. The vast amount of literature on the pituitary hormones is reviewed as is also the international statistical studies concerning the Aschheim-Zondek and Friedman hormone tests for early pregnancy.

The smallest section of the book is properly devoted to endocrine therapy because we know least about this. Clauberg takes a sane view of the usefulness of this form of therapy for disturbances in the physiological and reproductive functions in women. He not only cites his own extensive experience but he also reprints the opinions of a number of gynecologists as expressed in answer to a query which appeared in the *Medizinische Klinik* during the summer of 1934. He fully appreciates that endocrine therapy is in constant flux and that the future holds much in store for this new type of treatment.

Each section of the book has a complete bibliography of international references, which will prove useful to those interested in the subject of endocrinology. The bibliography for the third section which is the largest, occupies eighty closely printed pages. The book contains numerous illustrations all of which are clearly printed and instructive. However, this volume is enormous in size and weight, precluding the possibility of holding it in one or even both hands for reading purposes. The soft covered edition is especially clumsy and impractical because of the tendency for pages to fall out. However, the most serious drawback is the price of the book. The soft covered edition is sold for 189 marks which at the present rate of exchange is equivalent to about 76 dollars. This is a ludicrous price to pay for a

[1] GYNECOLOGY FOR NURSES. By Harry Sturgeon Crossen, M.D., and Robert James Crossen, M.D. 2d ed. St. Louis: The C. V. Mosby Co., 1936.

[2] VEIT'S HANDBUCH DER GYNAEKOLOGIE. Edited by W. Stoeckel. 3d rev. enl. ed. Vol. 9. DIE BEDEUTUNG DER INNEREN SEKRETION FUER DIE FRAUENHEILKUNDE. By W. Berblinger, C. Clauberg, and E. J. Kraus. Munich: J. F. Bergman, 1936.

single new volume of about 1100 pages which does not even contain any expensive plates, colored or otherwise. Furthermore, because of the important advances made in endocrinology during the last year and a half the book already lacks completeness. Nevertheless as a reference book, this volume is unsurpassable.

J. P. GREENHILL.

THE monograph by Castle and Minot[1] was written for the *Oxford Loose-Leaf System of Medicine* but was also published in book form in order to make it more generally available. All those interested in the subject of anemia will welcome a work by two such renowned authorities in this field. The book is written in a clear, concise fashion, and practically all important facts and theories related to the anemias seem to have been covered.

The first section of the book deals with the physiology of the erythron and includes various aspects of blood production and blood destruction. This is followed by a brief section on diagnostic methods in which some important suggestions in hematological technique are presented. Strict adherence to these details would result in an accurate laboratory diagnosis of anemia. Mean values are listed for the various measurements related to the erythrocytes and blood hemoglobin. A complete etiological classification of the anemias based on recent discoveries is outlined. The classification is simple and logical and deserves widespread use in the teaching of students. The clinical descriptions of each type of anemia include important points in the historical development and physiological facts and theories that explain the symptoms and signs of the condition. The consideration of variations in the leucocytes and blood platelets along with variations in the erythrocytes helps to give the reader a clear picture of the physiological state of the bone marrow in each type of anemia. Considerable space is devoted to the pathological physiology of the macrocytic and hypochromic anemias. The last part of the book is given over to the general and specific treatment of the anemias and the rationale of liver and iron therapy is fully discussed. Complete references on every phase of the subject are included and the large bibliography of 646 articles should be most valuable to those seeking special information. In recent years, most of the emphasis in the study of the anemias has been placed on that group due to deficiencies. In this volume, the other anemias receive the attention that they deserve. The analysis of these non-deficiency anemias from the standpoint of newer knowledge in pathological physiology and diagnostic technique helps to give a complete and informative picture of the entire subject. This excellent book can be highly recommended to physicians, students, and special workers in this field.

HOWARD L. ALT.

[1] OXFORD MEDICAL PUBLICATIONS. PATHOLOGICAL PHYSIOLOGY AND CLINICAL DESCRIPTION OF THE ANEMIAS. By William Bosworth Castle, M.D., S.M. (Hon.), and George Richard Minot, M.D., S.D. (Hon.), F.R.C.P. (Edin. Hon.). Edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.). New York: Oxford University Press, 1936.

AS noted in the preface, *The Eye and Its Diseases*[2] represents an effort on the part of 82 international authorities, each an investigator in a special field, to present the essentials of ophthalmology to physicians, surgeons, neurologists, medical students and those entering upon the practice of ophthalmology. The volume is edited by Conrad Berens.

The book is divided into 14 parts, each of the parts into chapters, each chapter presented by the chosen authority of that particular topic. The introduction consists of a brief history of ophthalmology. Part 1 is on the embryology, anatomy, and the postnatal development of the eye. Part 2 concerns the physiology of the eye and physiological optics. Part 3 takes up the examination of the eye with chapters on visual acuity, ophthalmoscopy, tonometry, color and light sense, perimetry, the slit lamp and the corneal microscope and transillumination. Part 4 is on refraction and accommodation. Part 5 concerns the diseases of the eye, and includes chapters on pathology, etiology, developmental defects, and heredity as general topics. The diseases of the eye are discussed following the usual classification dependent on the anatomical structure involved. Special chapters treat the subjects of trachoma, glaucoma and sympathetic ophthalmia. Part 6 is on medical ophthalmology. Part 7 concerns the movements of the eyeballs and their anomalies. Part 8 is on injuries of the eye. Part 9 takes up the eye and the nervous system. Part 10 is on treatment; subdivided into therapeutics and surgical treatment. Parts 11, 12, 13, and 14 concern preventive ophthalmology, immunology, the legal aspects of ophthalmology and laboratory diagnosis, respectively.

A definite need is supplied in American ophthalmological texts by this volume, concise chapters, up to date chapters, authoritative and complete in the topics concerning the eye and its diseases. Not only is this volume of practical value to those in the field of ophthalmology, but also to those outside the ophthalmological field who have an occasion to meet some ophthalmological problem. References, at the end of each chapter, are not lengthy but supply the reader with a source for further reading. It is easy to recommend highly such an ophthalmic volume that brings together as this volume does, completeness in topics and authoritative contributors. To the editor goes much credit in the organization of the volume and the selection of its authors.

WILLIAM DROEGEMUELLER.

IN the 9 years which have passed since the first edition of Macalpine's book[3] was published, many changes and advances have been made in urology. The author has revised and added new material with thoroughness and skill. This task represents an exhaustive review of the progress made in mechanical and chemical fields as well as modern conceptions of various phenomena met in urologic practice.

[2] THE EYE AND ITS DISEASES. Edited by Conrad Berens, M.D. Philadelphia and London: W. B. Saunders Co., 1936.

[3] CYSTOSCOPY AND UROGRAPHY. By Jas. B. Macalpine, F.R.C.S. (Eng.). 2d ed. rev. enl. Baltimore: William Wood & Co., 1936.

There are 27 chapters of which the last four deal with urography, instrumental and excretory, pyeloscopy, and pelvic resorption. The subject of perurethral resection of vesical neck obstructions is handled with admirable restraint. This procedure has aroused heated controversy and Macalpine, with sound judgment, advocates resection in selected cases only.

The volume is profusely illustrated with drawings and plates of the finest workmanship. The book, printed on art paper, is easy to read,—the style clear and concise. The reviewer believes that *Cystoscopy and Urography* is the best work of its kind, not only for the student and the surgeon, but for the urologist. L. L. VESEEN.

THE first edition of Walker's work[1] on the genito-urinary organs was published in 1914, a few months before the outbreak of the war. The demand was great and soon the book became unobtainable. Kenneth Walker, with concurrence and help of Sir John Thomson-Walker, has revised and edited the modern second edition.

Due to the progress of urology in the last 20 years, much new material has been added and the necessary revisions made. The anatomical classification is retained and simplifies quick reference to special subjects. Several new chapters have been added and some entirely rewritten.

In making a page by page comparison of the first and second editions, one is struck by the new conceptions and advances made by urology in a scant score of years. In the chapter "Obstruction at the Bladder Neck," for instance, it has been necessary to rewrite throughout, because of the recognition of small vesical neck obstructions which were formerly regarded as atrophies.

Tests of the renal function are presented in a few concise pages. The subject of renal calculus has been revised to admit new contributions to the general factors in the etiology. The management of malignancies now includes the employment of radium and deep x-ray therapy.

The subject of prostatic obstruction is supplemented by an evaluation of the status of perurethral resection. With characteristic restraint this procedure is adopted only in cases which have been carefully selected.

Kenneth Walker has rewritten the chapter on "Impotence and Sterility" in a simple comprehensive style. It is interesting to note that the chapter on "Gonorrhœa and Its Complications" remains unchanged after 20 years, a sad commentary on our progress on the less spectacular aspects of urologic practice.

Walker's *Surgical Diseases and Injuries of the Genito-Urinary Organs* well fulfills the hopes of the author. It is well suited as a textbook and will prove of value to the general practitioner. The urologist, as well, will appreciate this excellent exposition of his specialty. L. L. VESEEN.

[1] SURGICAL DISEASES AND INJURIES OF THE GENITO-URINARY ORGANS. By Sir John Thomson-Walker, D.L., M.B., C.M. (Ed.), F.R.C.S. (Eng.). 2d ed. rev. Edited by Kenneth Walker, M.A., M.B., B.C. (Cantab.), F.R.C.S. (Eng.). Baltimore: William Wood & Co., 1936.

THE book by Gosset, *Techniques Chirurgicales*,[2] is a review of the work of the surgical clinic of Salpêtière. For the past 20 years Gosset has been associated with this clinic, and his book, written by himself and members of his clinic, brings a word picture of the development and growth of his famous organization during these years.

These are 15 chapters, the first 4 dealing with the organization of his clinic. An excellent bird's eye view of the physical aspects of the organization is given in the first chapter together with the personnel of the group. The second chapter presents a most interesting discussion dealing with their problem of sterilization. The description of the pathological anatomy laboratory is interesting; their museum, photomicrographic department, the autopsy service as well as their department of pathology are described in detail. Chapter 4 describes the department of anesthesia.

The last 10 chapters describe methods of approach, technique, end-results, and mortality. Chapter 5 deals with the posterior approach for removal of the gasserian ganglion. The author (Petit-Dutaillis) reports 40 cases with 4 deaths.

The sixth chapter discusses cancer of the superior maxilla. They use surgery and radium combined.

There is a most interesting chapter on diaphragmatic hernia—the anatomy of the region, methods of approach, x-ray findings and therapy used are discussed.

Chapter 8 reviews their experiences with gastrojejunal ulcer in which gastric resection is employed; chapter 9 is a review of their work with gastric resection for carcinoma of the stomach. It is of interest to note that as the years have passed the percentage of operable cases has increased. Whereas in 1922 the percentage of operable cases was only 13.2 per cent, in 1935 it had increased to 42.5 per cent. This speaks highly for the ability of Gosset and his colleagues to recognize these cases earlier.

Chapters on appendicitis, intestinal obstruction, carcinoma of the right and left colon, uterine fibroids, and a final chapter on the surgical approach of fractures about the ankle joint completes this interesting volume. EARLE I. GREENE.

[2] TECHNIQUES CHIRURGICALES. By A. Gosset et al. Paris: Masson et Cie, 1936.

# AMERICAN COLLEGE OF SURGEONS

*PROCEEDINGS OF*

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*PHILADELPHIA*

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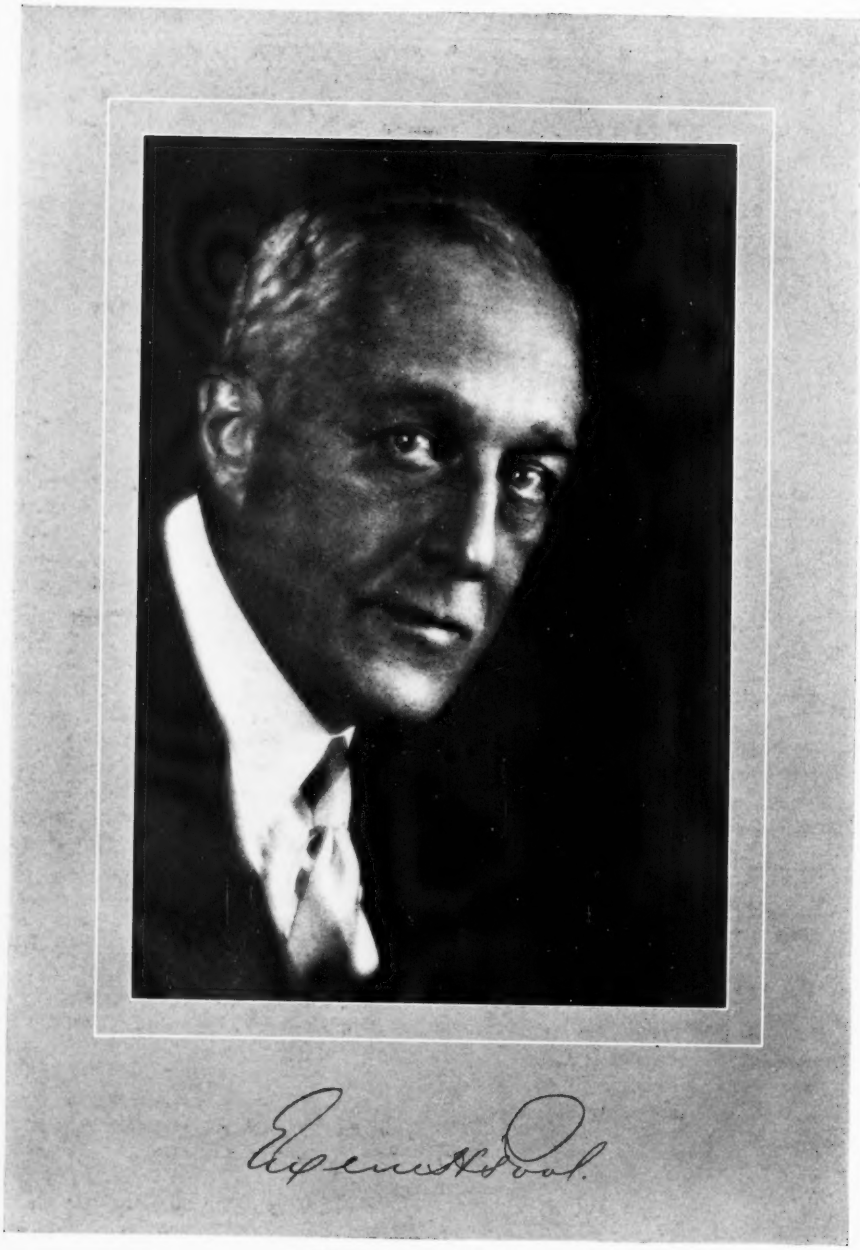

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# THE FORMATION AND TREATMENT OF CALCULI IN THE BILIARY DUCTS AND GALL BLADDER

SIR JAMES WALTON, K.C.V.O., M.S., F.R.C.S., London, England

IF civilization as we know it is not only to continue but is to progress, there must be free communication and a widespread friendship between the individual races. It has always been the boast of medicine that it is international, and in the pursuit of this ideal it can take pride, not only in disseminating its knowledge universally, but in bringing members from widely separated races into close and friendly relationship. In carrying out this civilizing function of the great brotherhood of medicine the American College of Surgeons has always taken a leading part. Not only have its officers and members collected and freely distributed the knowledge so arduously but so ably acquired in this country, but they have traveled widely and have always invited surgeons from other countries to take part in their discussions and meetings and thus have done much to stimulate international friendship. That you, the representative surgical body of this great nation, should have elected me to address you tonight confers upon me a very signal honor, for I feel that upon me rests the task, not only of representing English surgery, but of attempting to cement still more firmly the many lasting friendships between American and British surgeons.

Annual Oration on Surgery presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

The subject of surgery is ever of increasing interest. Now, as in the past, it rests upon a sound knowledge of anatomy and operative technique, without which no surgeon is complete; today, however, he is no longer a mere technician, for the knowledge of when to operate is of even greater importance than the knowledge of how to operate. Such knowledge can be acquired only by a careful study of physiology, pathology, and clinical medicine. It was the full appreciation of the importance of this, the more academic aspect of surgery, which gave the founders of your College the international reputation that they have all enjoyed. The importance of such studies is perhaps nowhere better seen than in the problem of the formation of gall stones. This subject has interested me for many years, for the consideration of its many aspects not only helps us to understand many of the basic principles of surgery, but alone gives us the key to successful treatment. I have therefore felt that it would not be without interest to you.

## TYPES OF GALL STONES

There are several varieties of gall stones and the pathological processes involved in their formation are not the same for all varieties.

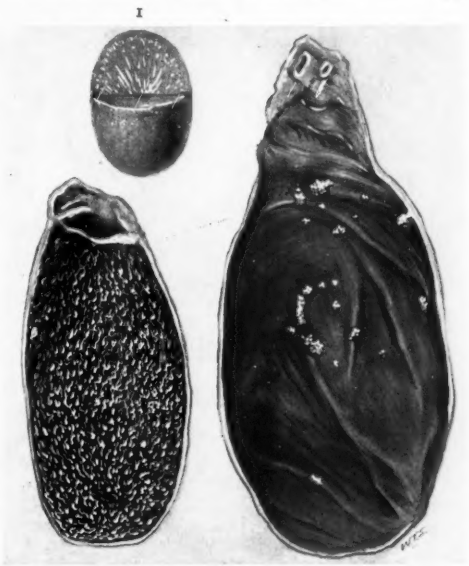
*Pure cholesterin stones.* Of the many types the pure cholesterin stone is the one, over the

formation of which there has been the most controversy. The stones are usually single, not more than three-fourths of an inch in diameter, oval in shape, nodular on the surface, semitransparent, and of a waxy consistency (Fig. 1). If cut into, they are always found to be amorphous in their outer layers although, as Bland-Sutton pointed out years ago, the center portion may have undergone a secondary crystalline change. At times they may be mixed with a certain amount of bile pigment and with calcium carbonate and in these circumstances tend more often to be multiple, but even so, it is rare to find more than three or four stones. As with other varieties of calculus, they are more commonly seen in stout middle-aged women who are usually married and have usually had children. When we remember that the main function of the gall bladder is to concentrate the bile, that during pregnancy the blood cholesterin is said to be raised, that stout women who eat largely of rich food are likely to have an increased cholesterin intake, and that with advancing age such patients become more lethargic, it would seem natural to believe that the formation of these stones is metabolic in nature. There is a curious and interesting condition in which the mucous membrane of the gall bladder shows on the apices of its folds the deposit of a lipoid material closely related to cholesterin which is known as a strawberry gall bladder (Fig. 2); that this condition is not infrequently found in eclampsia would seem to support the view that the deposit of cholesterin is due to a metabolic change. Sometimes these cholesterin-bearing portions of the mucous membrane form papilloma-like masses, suggesting that they may become free and so form the nuclei of stones (Fig. 3). The circumstantial evidence seems so strong that the view of Aschoff and Bacmeister that these stones are metabolic is almost universally accepted. Nevertheless I believe it to be incorrect. It is true that 75 per cent of gall stones occur in married women who have had children, but since they are usually found in women between the ages of 40 and 60, some 80 per cent of such patients would be expected to be married and to have children. As far as we know, cholesterin is never deposited in the common duct, and if a cholesterin or mixed stone is found in that situation, it can be accepted as a certainty that it was formed in the gall bladder. Neither is the power of the gall bladder to concentrate the bile an explanation, for with obstruction of the common duct due to carcinoma or chronic pancreatitis, a condition in which the bile is concentrated to its greatest degree, cholesterin stones are never found in the gall bladder. If the cholesterin were simply deposited from a supersaturated solution, it would almost certainly come down in a crystalline form, but such crystalline deposits are rarely seen, the outer and newly formed layers of the stone being always amorphous; also, the stone is not soluble in solvents of cholesterin owing to the presence of an organic basis. In my own experience the gall bladder in these cases has always shown chronic inflammatory changes; therefore I think it must be accepted that the cholesterin is deposited by a gall-bladder wall which is the seat of chronic inflammation. If the bile does not freely enter the cavity of the gall bladder, the stone will be of pure cholesterin (Figs. 4 and 5), but if the bile does enter, a mixed or laminated stone will result.

*Pigment calculi.* The pure pigment calcium calculi are entirely different in character and formation. The pigment may be either biliverdin or bilirubin. The biliverdin calculi are found most commonly in the gall bladder when they appear as small irregular dark green or almost black friable masses resembling small cinders (Fig. 6), whereas the bilirubin stones are most commonly seen in the obstructed common bile duct where they form putty-like masses filling the lumen of the duct (Fig. 7). If present in the gall bladder, they soon set up a cholecystitis and then become coated wholly or in part by a layer of cholesterin (Figs. 8 and 9), thus further supporting the view that the cholesterin is formed by the inflamed gall-bladder wall. The stones which are sometimes found in the hepatic ducts of young children and those which are formed in dilated and infected ducts are always composed of pigment calcium and contain little or no cholesterin. In diseases in which there is a profound destruction of red blood cor-

puscles, gall stones are frequently found and are then usually of this type. In temperate climates the commonest example of such a disease is acholuric jaundice, the later stages of which are certain to be associated with gall stones. I am also informed by my colleagues who practice in tropical climates that gall stones are common in severe cases of malaria and are then invariably of the pigment variety. An interesting condition is seen when there is a long continued obstruction of the common bile duct. It is well known that under these circumstances the bile is greatly concentrated and forms a thick, tenacious, tar-like material and that if any stones are present, they are always of the pure pigment variety. What is less widely realized is that the concentrated bile may become opaque to the x-rays owing to its large content of biliverdin calcium (Fig. 10); it is, in fact, a liquid stone. Stones of this type are not only friable, but are easily soluble, and are therefore difficult to mount as permanent specimens in a liquid medium. From these facts, it must be accepted that the pigment calcium calculi are metabolic in origin.

*Mixed stones.* The mixed or common stones are variable in size, shape, and number, but on section are nearly always laminated, the layers being alternately formed of cholesterin and pigment calcium. According to the nature of the pigment, the stones are either green or yellow. They may be single or multiple, and, if the latter, they are nearly always facetted, the stones as they grow in size fitting in to one another (Fig. 11). Hence if there is a collection of only two or three stones, they may be barrel-shaped, with facets at either end, but if there is a large number—there may, indeed, be thousands—, they fit into one another to form a compact mosaic. If single, they are frequently large and may entirely fill the gall bladder or may ulcerate through into the intestine, an intestinal obstruction from gall stones being nearly always due to a single stone which has reached the intestines in this manner. Stones of such a character are roughly nodular on the surface, these surface nodules fitting closely into the irregularities of the gall-bladder mucosa (Fig. 12).

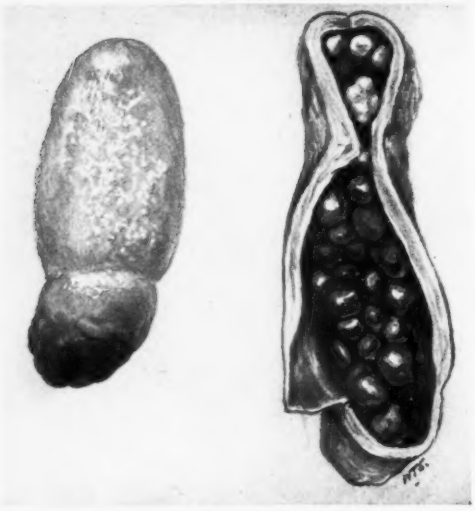


1 2 3

Fig. 1. Pure cholesterin gall stone.
Fig. 2. Strawberry gall bladder.
Fig. 3. Lipoid material forming papillary masses.

## METHODS OF FORMATION

The method of formation of these stones has in the past led to much discussion. The original suggestion of Galen and Frerichs that they were due to stagnation of the bile is still regarded by many as a partial explanation, for they are more common in women of middle age who are stout and who live sedentary and somewhat greedy lives. The view that they were more common in women because they wore corsets is no longer tenable, for women have ceased to wear corsets but they have not ceased to have gall stones. However, like the pure cholesterin stone, this type is not found when there is complete obstruction of the common bile duct. The belief in their metabolic origin also seems to be no more correct than in the case of pure cholesterin stones, for, although they are in very large part formed of cholesterin, they also do not occur as a deposition of crystals but are amorphous and have an organic basis and thus are not soluble. If there should be any crystalline structure at all, this is always found in the center of the stone and not in the peripheral layers. More-



4 5

Fig. 4. Stone in gall bladder; the upper portion shut off from the bile is pure cholesterin; the lower contains pigment.

Fig. 5. Hourglass gall bladder. Stones shut off from the bile in the upper compartment are coated with pure cholesterin. Those below are mixed.

6 8 7 9

Fig. 6. Biliverdin calculi.
Fig. 7. Bilirubin calculi.
Fig. 8. Biliverdin calculi coated with cholesterin.
Fig. 9. Bilirubin calculi coated with cholesterin.

over, also like the cholesterin stones, they are formed only in the gall bladder and never primarily deposited in the ducts. This fact may be of very considerable prognostic importance, for if a patient who has had a previous cholecystectomy returns with evidence of a stone in the common duct, there may be considerable doubt as to whether the removal of this stone will be followed by subsequent calculus formation. After the stone is removed, a dogmatic opinion may be given, for if on section it is found to be laminated, it was certainly formed within the gall bladder and therefore had been overlooked at the time of the cholecystectomy, in which case its removal is almost certain to be followed by a complete cure. If, however, it is formed of pure pigment, it may have been deposited in the inflamed common duct, and if this inflammation persists, further stones may be formed.

There is a tendency today to forget the detailed work of the older investigators, but I believe that the views of Naunyn published more than 50 years ago are still correct. He showed that the formation of stones was always dependent upon an inflammation of the gall bladder, the desquamated epithelial cells of which acted as nuclei. It is to Galippe that we owe the knowledge that micro-organisms are found in the gall bladder in association with stones, and to Mignot, the knowledge that the inflammatory changes are always chronic. With an acute inflammation, there may be pus and necrosis of the gall bladder, but stones are not formed. It was in the days when typhoid fever was a common disease and was a frequent precursor of gall stones that so much was added to our knowledge, the work of Welsh, Hanot, and, later, of Deaver putting the evidence of chronic infection on a firm basis. Later investigators showed that many other organisms may be present, the infection most frequently being with the Bacillus coli, although at times it may be pneumococcal or influenzal; thus, as typhoid has tended almost to disappear, gall stones have not become less frequent.

The greater frequency of stones in women probably lies in the fact that the Bacillus coli

Fig. 10. Roentgenogram of concentrated bile in gall bladder with obstructed common duct. *No* dye administered. *No* gall stones present.

Fig. 11. Multiple mixed calculi.
Fig. 12. Single mixed calculus.

is so common a cause. Women are much more prone than men to Bacillus coli infections of the urinary tract which not infrequently follow pregnancy. These infections are almost certainly not limited to the urinary tract but are a general septicemia. Some 30 years ago I investigated a series of 347 cases with gall stones in the London Hospital and found that 70 per cent of these cases had Bacillus coli in the urine. If pregnancy is a factor at all, and I doubt very much whether it has been proved, this is because it increases the tendency to Bacillus coli infections, rather than to any bearing it may have upon the formation of cholesterin.

### METHODS OF INFECTION

If it be accepted that the stones have an inflammatory origin, the path by which the infection reaches the gall bladder becomes of considerable interest. It would be natural to assume that it passed up the common bile duct from the duodenum, but it is interesting to note, throughout the body generally, that there is an increasing weight of evidence to show that infection very rarely occurs by what may be regarded as the natural paths. It would seem as though the protection against infection along these paths is so well developed that it hardly ever occurs. One need only mention that modern evidence seems to show that lesions of the stomach are rarely due to the ingestion of infected food, and that infections of the kidney are nearly always blood or lymphatic borne, rarely taking place directly up the ureter even if there is an obstruction. In the same way it seems to be very doubtful whether an infection takes place up the common duct. Although it is true that carcinoma and pancreatitis, both of which lead to obstruction of the common duct, may be associated with gall stones, yet it would appear that the gall stones in such cases are of long standing and are primary rather than second-

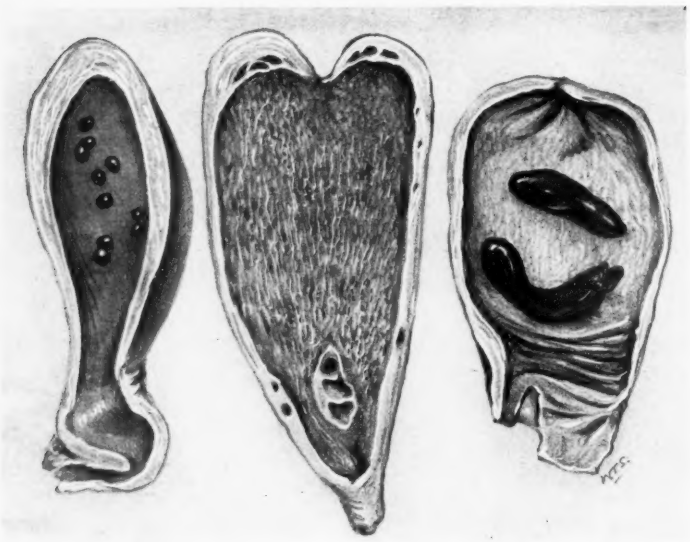


Fig. 13. Chronic typhoid cholecystitis.

Fig. 14. Intramural calculi.

Fig. 15. Calculi formed around sutures.

ary to the carcinoma. In those cases in which stones are not present, carcinoma of the common duct or pancreatitis gives rise to much distention of the gall bladder, but there is no evidence of the presence of cholecystitis. In the majority of cases of gall stones, the common duct is free and there is no cholangitis. If there be a cholangitis, it nearly always occurs with a stone which has passed into the common duct and therefore appears to be secondary. As a rule, there are very few organisms in the duodenum, although Hurst's suggestion that the infection herein may become increased owing to the achlorhydria which is usually found with gall stones is of interest, but I think it is discountenanced by the fact that cholangitis is so rarely found, and that when it does occur, a complete cure is obtained by cholecystectomy. It therefore seems certain that the formation of stones is not commonly due to an infection passing up the common bile duct. For the same reasons it is unlikely that the infection passes from the intestine along the portal vein to the liver and so is excreted in the bile down the common duct, and this in spite of the fact that the theory is attractive in that organisms so excreted would probably be attenuated and so would be more likely to cause a chronic cholecystitis. In many diseases organisms are so passed in the bile but they do not cause cholecystitis.

It is now universally accepted that the infection most commonly occurs, not in the bile, but in the substance of the gall-bladder wall. Graham and Illingworth and Wilkie have found that organisms injected into the lumen of the gall bladder produce no change, but if injected into the substance of the wall, they give rise to a cholecystitis which is later followed by the formation of gall stones. Gordon-Taylor and Whitby obtained similar results, but, whereas Illingworth and Wilkie found that the most frequent organism was the streptococcus, they found that the Bacillus coli or Bacillus welchii was the most common infection.

These findings have been confirmed by many other investigators and are supported by Rosenow's work showing that infection, not only of the gall bladder, but of the stomach and duodenum could be experimentally produced by organisms carried through the blood stream and also by Mann's interesting

Fig. 16. Male aged 59. Roentgenogram of gall bladder containing 15 stones and one in cystic duct. Before treatment.

Fig. 17. Same patient. He was given 2 months of medical treatment with oils during which he was shown 18 masses said to be gall stones which he had passed. The day after leaving the home he had another attack of colic and the above roentgenogram was taken. He still had 15 stones in the gall bladder and 1 in the cystic duct. He was operated upon and now has 16 stones in a box.

experiment which showed that the intravenous injection of Dakin's fluid was rapidly followed by the onset of acute cholecystitis. The fact that cholecystitis may be due to specific organisms, such as those of influenza and pneumonia, lends clinical support to the view that the infection is carried to the wall by the blood stream. Interesting pathological conditions may be seen which also favor this belief. Figure 13 shows a gall bladder which was removed from a patient who had had typhoid fever some years before and was a typhoid carrier. After removal of the gall bladder the typhoid bacillus disappeared from the stools. The pathological interest lies in the fact that there is gross thickening of the walls, manifestly of many years' standing, with only a few small stones, suggesting that the infection was primarily in the wall. The presence of intramural calculi without stones in the gall bladder also indicates a primary infection of the wall which spreads to the small crypts of the mucous membrane while the main cavity escapes (Fig. 14). In the days when cholecystostomy was the routine operation, the purse-string suture employed to invaginate the fundus of the gall bladder occasionally ulcerated through into the lumen and became the nucleus of a calculus (Fig. 15). The evidence of a primary infection of the wall, although suggestive, is not here so definite, for round worms traveling up the duct may become the center of a calculus, even though there has been apparently no injury to the gall-bladder wall.

Of late the view, which has been so ably supported by Graham, that infection is carried to the gall bladder by the surface lymphatics from the liver has gained many supporters. In most cases of cholecystitis there is evidence of an adjacent hepatitis, but in my own experience this is very localized and would thus appear to be secondary to the infection in the gall bladder.

The balance of evidence today, therefore, seems to support the view that infection most commonly occurs through the blood stream and is carried thereby to the wall of the gall bladder.

In the case of pigment stones the solid material appears to be simply deposited from a supersaturated solution so that a mass of

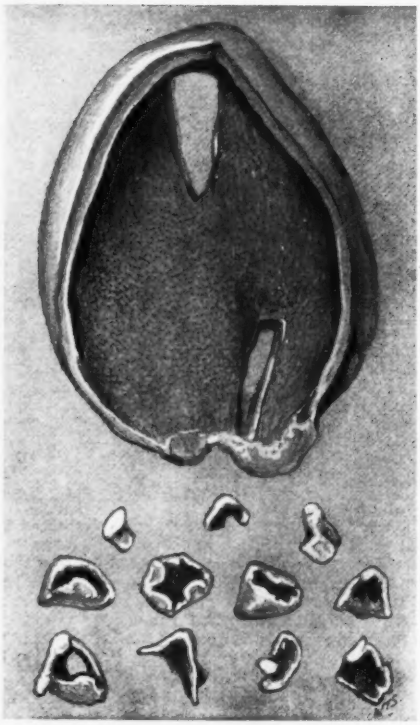


Fig. 18. Partial solution of gall stones.

Fig. 20. Roentgenogram showing presence of stone in patient 19 years of age.

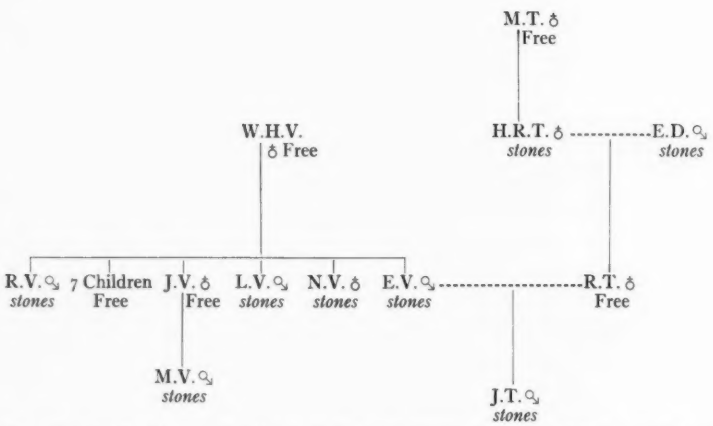



Fig. 19. Family history of Miss J. T. aged 19 years. Pigment calcium stones in gall bladder and common duct.

friable and easily soluble crystals is formed. With the mixed and pure cholesterin calculi, the method is different, for the stones are not crystalline and they are not soluble. It would seem that the inflammation of the gall-bladder wall leads to the formation of an irreversible colloid and that by a process of adsorption the crystalline material is deposited so that in every stone there is an organic basis. It is possible that desquamated epithelium acts as a nucleus, and that if there are many nuclei, a large number of stones is formed. The further progress will depend upon whether the cystic duct is open or closed; if it is open and there is free access of bile, pigment will be present, and it would seem as though the formation of the common laminated stone is dependent upon alternating periods in which the cystic duct is opened and closed. If the duct is obstructed and no pigment can enter into the gall bladder, the progress will depend upon the acuteness of the infection. If it be acute, a severe cholecystitis will develop before the stone has time to increase in size, but if it be chronic, cholesterin will be deposited from the inflamed wall and a pure cholesterin stone will result.

An understanding of the above principles makes it evident that cholesterin and mixed stones cannot be dissolved *in situ;* nevertheless patients are still often told that their stones can be dissolved by taking large doses of olive oil. If a gall stone be boiled in olive oil, it will be left almost unaffected; thus the futility of such a procedure is evident. An interesting example of a case so treated is shown in the roentgenograms (Figs. 16 and 17). A patient having had attacks of colic was seen by his practitioner and roentgenogram investigation was carried out. The plates revealed the presence of 15 stones in the gall bladder and 1 stone in the common duct. A physician informed him that he could dissolve the stones with olive oil and after a course of such treatment he was presented with 18 objects which were said to be stones that he had passed. He went on his way rejoicing but on the next day developed an attack of biliary colic. Further roentgenograms revealed that he still had 15 stones in the gall bladder and 1 stone in the common duct, which were then removed at operation. With pigment stones the reverse would be expected, for if, as we believe, they are a simple deposition from a supersaturated solution, they should be capable of again entering into solution. I have a specimen, which I believe to be unique, of gall stones formed of masses of pigment upon which an incomplete coating of cholesterin had been deposited in the gall bladder (Fig. 18). At operation many of the stones showed considerable absorption of the pigment, leaving the cholesterin as an empty shell which resembled hollow and carious teeth. The practical importance of this is that in severe cases of acholuric jaundice and other hemolytic diseases, it would be permissible to remove the spleen or other cause and to leave the stones in the hope that they might later be absorbed. The chance of success, however, is only small, for when the pigment stones have been in the gall bladder even for a relatively short time, cholecystitis is set up and a deposit of cholesterin occurs which will prevent solution. Fortunately, however, these pigment stones usually give very good shadows in the roentgenogram and therefore the progress can easily be watched.

*Calcium carbonate stones.* The majority of stones contain a small proportion of calcium carbonate, but on rare occasions specimens may be seen which are formed of pure calcium carbonate. In the London Hospital Museum there are two examples, but they are undoubtedly rare. In the best example of my series there were 11 stones in the gall bladder and 28 in the common duct. They were about a third of an inch in diameter, white in color, roughly nodular on the surface, and stony hard. In exceptional cases a curious condition is seen, to which attention has been drawn by Schubb and Goodstone; the gall bladder contains a mass of semisolid white material looking like soft cement or plaster of Paris. It consists of almost pure calcium carbonate which may occur alone or may be associated with stones of the common type. There are two such cases in our Museum at the London Hospital, and strangely enough, one of them occurred in a case of acholuric jaundice in which the stones should have been of the pure pigment variety. The factors which lead to

the formation of this type of deposit are unknown.

TREATMENT

An appreciation of the above pathological processes is not merely of academic interest, but is of practical use in the consideration of treatment, for stones may occur under many different conditions which will threaten the life of the patient to a varying degree.

*Uncomplicated stones in the gall bladder.* Calculi may be found accidentally when a roentgen-ray investigation is being carried out for some other condition. Occasionally there may be a marked family history so that attention may be directed to the gall bladder even when the symptoms are indefinite. Such a history is shown in Figure 19. The patient was a young girl of 19 who had complained only of slight pain in her right side, but because of her family history she was subjected to x-ray examination and the presence of stones (Fig. 20) was revealed.

More commonly patients are seen who are suffering only with a mild degree of flatulent dyspepsia immediately after meals. Indeed, this is the sole symptom of uncomplicated stones in the gall bladder, so that a positive diagnosis may rest upon the x-ray findings. It is necessary, however, to issue a warning against the modern tendency to suspect the gall bladder when there are ill defined toxic conditions, such as headache, pyrexia, or arthritis, and to perform a cholecystectomy because a good shadow of the bladder is not obtained with the dye. The dye when administered by mouth has to be absorbed by the intestines, excreted by the liver, passed freely down the common duct and up into the gall bladder, and has to be concentrated there. A failure of any one of these steps will give rise to a negative gall-bladder shadow; therefore, such a finding is not positive evidence of cholecystitis. Today a large number of healthy gall bladders are being most inadvisably removed on this evidence alone. Not only may the true cause of the symptoms be overlooked, but the cholecystectomy may cause discomfort. The function of a gall bladder which is grossly diseased has already been lost so its removal does not cause symptoms; this is not true when the gall bladder is normal.

In these uncomplicated cases there is no immediate danger to life from the presence of the stones, and the risks of operation must be carefully balanced against those of the disease. On the one hand, unless the stones be of the pigment variety found in hemolytic disease there is no possibility of their absorption, and if left, complications will probably occur later. On the other hand, it may be possible by careful attention to the patient's diet and life routine to keep her comfortable and free from danger for many years. There is no surgical procedure which is quite free from risk, and a cholecystectomy must always be regarded as a major operation, for the exact anatomical condition is revealed only when the abdomen is opened. It is never justifiable to advocate a dangerous operation for a condition which does not threaten life. The late Mr. Jeans very wisely remarked that "a living problem is better than a dead certainty," and this is especially applicable to cases of gall stones. If the patient is young and healthy, she will stand an operation well; inasmuch as she has a long life expectancy, she might develop serious complications if left; therefore an operation should be advocated. In old, stout, and unhealthy patients, however, it may be wiser to carry out palliative treatment in the hope that no complications will develop. Angina pectoris and other heart lesions are often associated with, and appear to be dependent upon, gall-bladder disease, and their presence is therefore an indication for operation rather than the reverse. Even if the patient has had colic, it may be wiser, if the attacks are rare and if she is a bad risk, to advise medical treatment in the hope that further attacks may be prevented and that she may be enabled to live in happiness and comfort. If, however, the attacks are becoming frequent and making her life miserable, resort to operation should manifestly be made. The greater the discomfort and the more imminent the risk of complication, the clearer will be the indication for operative interference.

*Acute cholecystitis.* It is almost certain that sooner or later the presence of gall stones will be associated with an acute inflammation. This may be gradual in its onset, but if a stone becomes impacted in the cystic duct or in

Hartmann's pouch, the onset may be almost fulminating and will immediately follow an attack of severe biliary colic. If there is no obstruction, the wall will show much inflammatory change, but if there is obstruction, the bladder will also be much dilated. I am confident, however, that it is impossible in either case to determine the extent of the inflammatory change and the amount of the risk of gangrene or perforation. In the early stages the symptoms are usually quite definite. The severity of the pain which has been gradual or acute in onset, the nausea and vomiting, the pyrexia and a considerable degree of rigidity and tenderness in the right hypochondrium are characteristic. The presence of such symptoms is evidence of a grave complication. It is frequently stated that acute cholecystitis will nearly always abate with medical care and that operative interference should be delayed until the patient's condition has improved and the inflammation has become localized. With such a procedure I am in entire disagreement. That some cases may localize and quiet down is certain, but I am confident that it is impossible to determine which case will do so and which will progress. In my own experience the risk of immediate operation has been no greater than waiting for a few weeks. The operation is much easier because all the tissues are edematous and the adhesions are recent and can be easily separated. Only too often I have been asked to operate on a case that has been watched for some 2 or 3 weeks. A tumor is still present and at operation there is a dense mass of firm omental adhesions. In many cases there have been perforations of the gall bladder into the omentum or into the substance of the liver, and in some cases I have been called in only when a free perforation has taken place into the peritoneum. In any case the operation is always one of difficulty and is often associated with considerable risk to the patient. I therefore unhesitatingly advise that the onset of acute cholecystitis should be regarded as a grave emergency and that immediate operation should usually be advocated. Occasionally old and fragile patients should be taken into the hospital and watched for 12 or 24 hours, not so much in the hope that the condition will abate, but rather that preliminary treatment may improve the general condition. Should the symptoms progress, an operation can be performed at any moment.

The ideal operation should consist of a cholecystectomy with exploration of the common bile duct from within; I am in the habit of teaching that no operation for gall stones is complete unless the common duct has been explored in this manner. As a general rule, the passage of a stone is associated with jaundice, but stones may be found in the duct when there has never been any jaundice. It has been said that a stone within the duct can always be felt from outside, but this is emphatically not my experience, and therefore my routine habit is to divide the cystic duct and then to tie and divide the artery. The cystic duct is then slit up and a pair of forceps inserted down to the ampulla. If any stone is felt, it is removed. If not, the forceps are gently passed through the ampulla into the duodenum and then opened so as to dilate the papilla, thus allowing free drainage of the duct into the duodenum. In each case, however, the risks must be balanced. In a stout and unhealthy patient, exploration of the duct from within will increase the risk of the operation, and if there has been no jaundice, if no stone can be felt from without, and if the cystic duct is narrow, the risk of overlooking a stone in the common duct is small; therefore, this step should not be undertaken. In old and fragile patients even the removal of the gall bladder may be a dangerous procedure, so that it is safer to perform a cholecystostomy. This, however, I perform very rarely and regard it only as a palliative life saving procedure which will probably be followed by after trouble but may enable us to tide the patient over a grave disaster.

*Chronic cholecystitis.* A gall bladder which shows a long standing chronic inflammation is thickened, distorted, and fibrous, and in the later stages may even show calcareous changes. The pressure of stones, especially if large, may cause sloughing of the wall with the formation of adhesions to a neighboring viscus and later the establishment of a fistula, usually into the duodenum, the colon, or the sub-

stance of the liver. The presence of chronic cholecystitis is usually made manifest by a history of several attacks of subacute or acute cholecystitis and of colic. The frequency of these attacks, the risk of obstructive jaundice, and the danger from an acute attack of cholecystitis are indications for interference, but the extent of the adhesions and the anatomical distortion will increase the difficulties and dangers of operation. In the earlier stages, and especially with the condition of strawberry gall bladder, the symptoms may be very indefinite unless the stones, which in my experience are nearly always present, have caused attacks of colic. The indications for operation are then not clear, and even when the abdomen is opened they may not be evident. The characteristic bladder which is the site of chronic inflammation is thick walled and opaque so that the bile does not show through and give the normal blue color, but occasionally there may be a definite strawberry gall bladder with little or no thicken ng of the wall. In such cases stones can usually be felt. It is well for the surgeon to remember that the more normal the gall bladder which is removed, the less satisfactory are the after results, and if, therefore, at operation it appears to be normal, the surgeon will usually be well advised not to perform a cholecystectomy. It is more probable that the symptoms are due to a mild degree of chronic pancreatitis. Should a fistula have developed between the gall bladder and some other viscus, it is only occasionally indicated by the x-ray investigation. Sometimes the first evidence of its presence is the onset of an acute intestinal obstruction when an immediate operation is of course an urgent life saving necessity.

With chronic cholecystitis the operative technique is more prolonged and difficult and a tedious dissection may be necessary to reveal the anatomy. With the more general introduction of cholecystectomy, there has of late years been an alarming number of cases in which the common bile duct has been injured at operation. If every surgeon would remember that no duct must ever be divided until all three ducts, the hepatic, the common, and the cystic, are clearly revealed, this accident could not happen. Apart from these technical difficulties, the operative steps are similar to those in the previous groups. In every case of cholecystectomy a tube should be inserted down to the closed stump of the cystic duct, for occasionally there are small accessory bile ducts which pass directly from the liver to the gall bladder and these are, of necessity, divided in the performance of a cholecystectomy. If a tube is used, there is a little leakage of bile for a few days and the wound then heals, but if no drainage has been provided, trouble may ensue.

*Impaction of a stone in the common duct.* The diagnosis of a stone impacted in the common duct is often difficult. In a typical case the patient will have had a long past history of stones in the gall bladder. Attacks of biliary colic will then ensue and these will be followed by jaundice. There will be a close relationship between the onset of the pain and the presence of the jaundice; the latter, if persistent, will tend to be variable in degree and a certain amount of bile may be passed in the stools. Probably because of the incompleteness of the obstruction the patient will remain a bright orange-red color and will not pass to the gray-green jaundice which is so characteristic of complete obstruction. As a rule, the gall bladder will not be distended and the liver will become but little enlarged. Although incomplete, the jaundice may, however, be sufficiently advanced to give rise to profound irritation of the skin and it may be of so marked a degree that the liver function fails and the ducts are filled with white bile, although this is much less common than with complete obstruction of the duct.

Although this is the characteristic picture, there must at times have occurred to us all the pleasing experience of having found a stone when we expected a carcinoma of the head of the pancreas or of the common duct, but on the other hand, the reverse is sometimes found, and occasionally the jaundice of a hepatitis may so closely resemble that of a common duct obstruction that an unnecessary operation is performed. I cannot, however, agree that the presence of jaundice is a contraindication to operation. It has been my experience, and I have always taught, that the presence of jaundice is itself a grave compli-

cation. It is an indication of back pressure upon the liver, and if left, may soon be followed either by evidences of liver failure or by the presence of rigors indicating the onset of suppurative cholangitis. If, therefore, the history is characteristic and a positive diagnosis can be made, I regard the onset of jaundice as an urgent indication for operation. If, however, the picture is atypical, with uncertain laboratory findings and the balance of evidence in favor of hepatitis, the patient should be watched, usually for a period of 6 weeks, before an operation is advised. The operative steps for a stone in the common duct will be similar to those for cholecystitis, the duct being opened from the stump of the cystic duct, the stone removed, and the ampulla dilated. In practically every case a stone impacted in the ampulla can be removed by this route. Only once have I found it necessary to do a transduodenal removal and only once to open the retroduodenal portion of the duct. It is always well to remember that if there are several stones with greatly dilated ducts, one may slip up so high into the hepatic ducts that a stone cannot be reached with forceps and so may be overlooked. Every surgeon therefore should take a generous view when he has to treat a case of apparent recurrence after an operation performed by another surgeon; such misfortunes may happen to us all.

After removal of the stone, a decision has to be made concerning drainage of the duct. It used to be my custom to state that there were four indications for such a step: (1) the presence of a dilated duct; (2) the presence of recurrent gall stones; (3) the presence of several putty-like stones indicating a chronic cholangitis; (4) the presence of pus within the lumen of the duct. Since I have been dilating the ampulla as a routine step, I have drained the common duct much less frequently and usually I insert a tube only when there is definite suppuration. I have never seen the necessity for using a T-shaped tube as advocated by many surgeons. It is difficult and dangerous to withdraw and shows no advantage over a simple tube which can be inserted into the common duct and sutured into position with plain catgut. If there is definite pus, it should point upward so that there is complete drainage, but if there is less infection, it may point downward so that the bile is more likely to pass alongside it into the duodenum. It should be kept in position for 10 days when the catgut will be absorbed and easy removal will be allowed.

In all operations for gall stones the surgeon must ever keep in mind that there is no area in the body in which there are so many congenital variations and so many pathological alterations in the anatomy and that a small error in technique may be followed by serious or fatal results. Therefore these operations more than all others emphasize the lesson that no structure must be divided until the anatomy has been clearly defined. Even with this precaution, I trust that I have been able to show you that the surgery of today is much more than an exercise in mechanical technique. Successful treatment can be based only on a wider clinical and scientific knowledge. It is this knowledge which the American College of Surgeons does so much to foster and to develop.

# CORONARY SCLEROSIS AND ANGINA PECTORIS

## Treatment by Grafting a New Blood Supply upon the Myocardium

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MAN'S power to investigate and to interpret has given him an ability to build machines that truly rival the machines of animal protoplasm. Indeed, in many ways these man made machines surpass the human body itself. By virtue of this ability surgeons are constantly being called upon to correct and to repair the human body. As the decades of experimentation pass by, our understanding rapidly increases and the defects of the human body are brought more and more to light. Only in the last two decades have we become aware of a defect that so frequently brings the human machine to a dead stop. For many years this defect was what the layman termed "acute indigestion." But we now know that indigestion has never really killed a man and we know that the trouble is in the heart. We know further that the trouble is primarily not in the heart muscle but in two small coronary arteries that feed the heart muscle. The turtle and other reptiles have several arteries that nourish the heart muscle. In this respect the turtle is better protected than is man. Nature has intensified this grievous mistake in man by depriving the heart muscle of continuity with adjacent tissues. Man's anatomical pattern gives the heart contact, but little or no continuity, with the body. She has anchored the heart in the body, suspended it by the great vessels, and has thereby effectively deprived the heart of an ability to build collateral anastomoses. These two anatomical facts—(1) that the myocardium has only two coronary arteries, and (2) that the heart has been deprived of continuity with the rest of the body—can be interpreted as two important defects in the construction of the human machine.

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The death rate from sclerosis of the coronary arteries is appalling. Of the physicians who died during the first half of this year, as recorded in the *Journal of the American Medical Association*, 14.6 per cent were given a diagnosis of coronary thrombosis, coronary sclerosis or angina pectoris. The life of the individual is placed in constant jeopardy when his coronary arteries become occluded. The maintenance of the heart beat depends upon the patency of these arteries. The cause of death is not beyond comprehension. Indeed, it resolves itself into one or two rather simple considerations. One of these is the amount of arterial blood available for the myocardium. Another consideration, the importance of which has been overlooked to a great extent, is the distribution of this available blood to every part of the myocardium. We know that certain compensatory adjustments take place in the myocardial circulation as the occlusive disease develops. A major branch of a coronary artery, or indeed the entire artery, may become occluded with preservation of the heart beat. In such cases the remainder of the coronary system may be sufficient to carry on and the adjustment may be nothing more than a redistribution of available blood. It is excessively rare for both coronary arteries to become completely occluded. When it occurs, the arterial blood supply must come from sources other than the coronary system. It must come through the thebesian channels or through the anastomoses with the aorta that exist in the fat at the base of the heart. While these compensatory mechanisms are of importance in that they can prolong life, nevertheless, they are dreadfully inadequate. The fearful mortality from coronary disease attests to the inadequacy of all compensatory circulatory mechanisms in the heart.

The question arises as to whether additional anastomotic channels to the heart can be given

by operative measures. When I began the experimental work on this subject 5 years ago, this idea seemed like an enormous stretch of the imagination. There were only a few facts to use as a working basis. One was the demonstration of blood vessels in the fat at the base of the heart anastomosing the coronary system with branches from the aorta (4). Another fact was the demonstration of blood vessels in adhesions to the heart (7). During an operation upon the human heart I had the experience of cutting a band of adhesions that extended from the base of the left ventricle to a thick pad of scar that was compressing the heart and I found that each end of the transected adhesion bled briskly. This is the first observation that such bands of adhesions can, and actually do, transport blood to the human pulsating heart.

The study of this problem experimentally involved two general considerations. One of these was to duplicate sclerosis of the coronary arteries. A need for blood had to be produced in the myocardium. Perhaps a more accurate statement of this is the production of a pressure differential between coronary and extracoronary circulations. This was brought about by placing silver bands around the coronary arteries close to their origins from the aorta. These silver bands were then flattened, a little at a time at successive operations, until complete occlusion of the artery was effected. The other requirement of the experiment concerned the tissues that could be used as a source of arterial blood. We used mediastinal fat, pericardium, pedicle grafts of skeletal muscle brought in from the chest wall, and omentum brought up through opening in diaphragm.

Briefly stated, we were able to occlude the major coronary arteries with preservation of the heart beat and without infarction. It was concluded on the basis of experiment that the heart could be given an additional supply of blood by operative measures. In some of the experiments the anastomoses seemed to be rich enough to justify application of these operative measures to human patients suffering from coronary disease.[1]

[1]Dr. V. L. Tichy collaborated in the first series of experiments on this subject. I also want to give credit to Dr. Frederick Mautz and Dr. Alan R. Moritz for their valuable assistance. The reader is referred to the original publications for details of the experimental work on this subject (1, 2, 3, 6).

The work on human patients has been carried out in collaboration with our cardiologist, Dr. Harold Feil. The work on the human patients will be reported in detail elsewhere. It resolves itself into two important considerations. One of these concerns the principle itself. Can the blood supply to the myocardium be increased by grafting tissues upon the heart in a patient suffering from coronary sclerosis and is the effect beneficial? To this question we believe an affirmative answer can be given.

Dr. Feil's notes on one of our best results are as follows:

> The patient was a white male, aged 55 years, a machinist, who had had angina of effort for 2½ years. He also had generalized arteriosclerosis and intermittent claudication. He had an attack of coronary thrombosis 2 years and 4 months previous to operation. He had been totally incapacitated for 5 months. Physical examination revealed a normal sized heart with feeble heart sounds and generalized arteriosclerosis. The blood pressure was systolic, 120 millimeters of mercury, and diastolic, 90 millimeters of mercury. The electrocardiogram showed typical changes in the S-T portion of the curve during induced anginal attacks. The operation was performed. The pericardial cavity was opened on each side of the sternum. The epicardium was roughened by mechanical means. A pedicle graft from each pectoral muscle was placed upon the right and left ventricles. After operation the patient became entirely free from anginal pain. Five months after operation he returned to his former job in the machine shop and he has been able to do hard work. He has worked regularly during the past year. The results in this case are excellent.

Has the blood supply to this patient's heart been augmented by the operation? The injection of the vascular tree sometime will give us a final answer.

The other important consideration concerning this operation upon human patients suffering from coronary sclerosis is the ability of the patient to withstand the operation. The patients upon whom the operation was performed were all advanced cases of coronary sclerosis. They were patients who had come to the conclusion that they were risking nothing by having the operation done because life without improvement was not worth while. While this attitude of mind helped the patient to reach a decision concerning the operation, at the same time we were getting an extremely

bad group of patients for this operation or for any operation. One died before operation.

Up to the present time I have carried out the operation on 16 patients with coronary disease. The mortality has been 50 per cent. This mortality must be reduced if patients with coronary disease are to be given the benefit of this surgical principle. How can this be done? It can be accomplished in two ways: (1) by selecting patients for operation who do not have such advanced disease of the coronary arteries, i.e., patients with angina pectoris but with a good myocardium and with sufficient reserve to carry them through an operation, and (2) by reducing the magnitude of the operation. What can be accomplished along these directions remains to be seen. The magnitude of the operation has been reduced. Instead of a bilateral approach to the heart as was made possible by the removal of two costal cartilages on each side of the sternum, a unilateral approach has been used. Instead of a pedicle graft from each pectoralis major muscle, only one such graft was used. The number of costal cartilages removed was reduced to one. In most of our operations the epicardium was removed or roughened mechanically by means of a burr. We have attempted to get away from this feature of the operation because the removal of the epicardium initiates many extrasystoles. Dr. Mautz (5) has found that procaine applied directly to the surface of the heart will block these impulses. In several of our patients I have placed powdered beef bone in the pericardial cavity for the purpose of producing a low grade foreign body reaction between heart, pericardium, and pericardial fat. In one patient who actually showed some edema of the ankles before operation, only one costal cartilage was removed, the pericardium was opened, powdered bone was introduced, and a graft of muscle was not used. In this patient we are relying upon anastomoses to develop between myocardium, pericardial fat, and fibrous pericardium. Additional studies must be made before this subject can be discussed further.

I should like to make one or two concluding remarks. This operation is a direct attack upon coronary sclerosis. Its purpose is to give the myocardium additional blood. Its principal purpose is to preserve the heart beat. It does not concern angina pectoris except in a secondary way. However, relief of pain in most of the patients who survived was marked. In several of our patients the relief from pain was complete. The functional capacity of the heart seems to increase after this operation is performed. The results in general seem to be good enough to encourage further development of this subject.

We have succeeded in reducing the mortality of the operation. The total number of patients who have been operated upon is now 20 (December 30, 1936). The last five patients—all extremely bad risks—have gone through the operation without a death.

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# RATIONALIZING TREATMENT IN ACUTE INTESTINAL OBSTRUCTIONS

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ANYONE who attempts to rationalize upon a matter is beset with all the dangers that befall a logician. However good and persuasive the processes of reasoning may be, in order that he arrive at a fairly accurate conclusion it is far more important that he who engages in the fascinating exercise of rationalization be in possession of precise and correct information. Some of you have no doubt already become sensitized to and impatient with this manner of deduction, being mindful of the brass idols which you have already cast aside because of the testimony of false prophets. Many of these disappointments have come about because such inferences were not substantiated by actual evidence. Philosophy or theory without the support of experiment or demonstration is untrustworthy.

In endeavoring to describe a rational attitude concerning the management of acute intestinal obstructions, I am not unmindful of how many times opinion and hypotheses have changed concerning the significance of various factors alleged to be of importance in bowel obstruction. If time proves some of the conclusions wrong which I set before you tonight, I must confess the error of having rationalized on incomplete factual data. In so far as has been practical, I have tried to avoid this pitfall by subjecting the conclusions here related to the crucial test of direct experiment.

Much has been learned concerning the factors which contribute to making interference with the bowel, the strainer of food and drink, a menacing disorder. In recent years a better understanding has come about of some of the truths which have been learned concerning the manner in which obstruction of the intestine affects the bowel wall and the bodily economy. The introduction of these principles into practice has brought, within the span of a few years, a much more encouraging outlook into this dismal chapter of abdominal surgery. Improvements in surgical techniques and increased diagnostic acumen were not reflected as directly in the results of treatment of acute intestinal occlusion as they were in many other acute abdominal ills. The enlightenment which has come with enlarged knowledge of the subject, however, has made itself felt. The risk assumed by a patient with bowel obstruction today is not nearly as great as it was before the turn of the present decade.

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## SUMMARY OF THE CONSEQUENCES OF OBSTRUCTION

We have departed widely from the long held conception that obstruction is essentially a toxemia occasioned by the absorption of a chemical poison of the nature of proteose or histamine from the bowel. The first important occurrence which shed luminous light upon the mysterious death from obstruction was the observation by Hartwell and Hoguet, in 1912, that the lives of dogs with duodenal obstruction could be prolonged from a few days to as long as 3 weeks by the administration of subcutaneous saline solution. It was not until after the lapse of a few years that the full significance of this demonstration became apparent. Then in the twenties, through the researches of Haden and Orr, Gamble and his associates, and the work of others, the explanation for the phenomenon which Hartwell and Hoguet had observed became apparent. The lethal factor in these obstructions of the upper reaches of the small intestine was definitely shown to be loss of fluids and chlorides through the agency of vomiting. A duodenal fistula was found to be fully as perilous as an obstruction at or above the lethal line of Draper-Maury (Walters, Kilgore, and Bollman, 1926).

| Clinical classification | Pathological classification | Treatment |
|---|---|---|
| I. Mechanical obstruction<br>A. Narrowing of lumen<br>1. Strictures of bowel wall<br>a. Congenital {Atresia, Imperforate anus}<br>b. Acquired {Inflammatory, Traumatic, Vascular, Neoplastic}<br>2. Obturation<br>3. Compression from without (especially pelvis and retroperitoneal duodenum) | Simple (except occlusions of the colon) | Operation, preceded by suction. In occlusions of the colon with great distention, immediate operation. |
| B. Intestinal obstruction due to adhesions and bands {Congenital, Inflammatory, Traumatic, Neoplastic} | Simple or strangulation | Suction, operation for persistent obstruction and in strangulation |
| C. Hernia<br>1. External hernia<br>2. Internal hernia<br>D. Volvulus<br>E. Intussusception<br>F. Errors in the development of the gut which give rise to intestinal obstruction (other than congenital stenosis) | Strangulation | Early operation |
| II. Intestinal obstruction due to nervous imbalance (physiologic obstructions)<br>A. Inhibition (paralytic) ileus<br>B. Spastic or dynamic obstruction | Simple | Suction |
| III. Vascular obstruction<br>Intestinal obstruction due to mesenteric thrombosis and embolism | Strangulation | Early operation |

Fig. 1. Chart showing a combined clinical and pathological classification of bowel obstruction with an outline of the treatment indicated in typical cases.

An unusual impetus was lent the study of intestinal obstruction by these observations, and investigators everywhere who were interested in the field, convinced themselves of the verity of these conclusions. Soon saline solution was heralded as a specific for the mischievous consequences of intestinal occlusion. It was not long, however, until it became apparent that the promise of longer life which saline solution held out to a dog with obstruction of the upper reaches of the bowel was not a benefit conferred upon the dog with obstruction of the lower ileum. It was obvious that the explanation of the lethal issue in high intestinal occlusion did not clarify the cause of death in ileal obstructions. It is to be admitted that even yet the lethal factors operating in ileal obstructions are not wholly understood. Testimony from the clinic indicated that saline solution was not as efficacious as it had been believed to be, and no improvement attending its employment had been reflected in the general mortality of acute bowel obstruction (McIver, 1934).

These and a number of other bits of evidence served to focus attention on the mechanical components of the obstruction problem. Time will only permit mere mention here of the more important known physiological effects accompanying obstruction.

A block to intestinal continuity causes intestinal distention which is both gaseous and fluid in character. Apart from ingested liquids, the following endogenous fluids provide an ample source for fluid distention of the bowel in obstruction: saliva, gastric and pancreatic juice, bile and succus entericus. Rowntree estimated that their daily total approximated about 7,000 cubic centimeters. The chief source of gas in the obstructed intestine is swallowed air—about 70 per cent; the remainder has its origin in gas brought to the bowel through the blood and that resulting from fermentation and putrefaction in the bowel. That swallowed air is the chief source of gas in the obstructed bowel can be demonstrated by transecting the cervical esophagus in dogs (the distal end must be inverted to prevent aspiration of air into the stomach). Following obstruction of the terminal ileum the survival period is long when liberal quantities of normal saline solution are given subcutaneously, and the gut does not distend. Presumably the fluid from the sources mentioned above (with the exception of saliva which is lost through the cervical esophageal

fistula) can be absorbed when swallowed air is excluded. At necropsy dilatation of the bowel is absent.

In consequence of an increase in its intraluminal content, the bowel distends and its wall becomes thinner. Exaggerated peristaltic activity becomes ineffectual in propelling the intestinal cargo beyond the impediment, but the resistance of the intestinal muscle to distention provokes colic-like pain. Increase in the volume of the intraluminal content enhances the intra-enteric pressure which in turn, when long continued, exerts a deleterious influence upon the bowel wall. Experiment has shown that absorption via the mesenteric veins in obstruction decreases as contrasted with the normal; there is, however, some increase in lymphatic absorption from the bowel. Division of the mesenteric lymphatic pedicle, however, does not appear to influence the course for the better in obstructed animals.

Great increases of intra-enteric pressure long sustained obviously compromise the blood supply of the bowel. The egress of blood from the mesenteric veins is impeded and the viability of the gut wall becomes threatened. A factor in obstructions of the small intestine which operates to offset this mischief in part is evacuation of the distended bowel by reversed peristalsis and vomiting. In obstructions of the upper reaches of the bowel, this agency alone may suffice to save the bowel from the injurious effects of distention and increased intra-enteric pressure; in ileal occlusions the lower segments of the obstructed bowel cannot be evacuated by this means, but regurgitation into more proximal reaches of the small intestine, which then also participate in the distention, serves to lessen the peril to the bowel wall. In obstructions of the colon, unfortunately, the ileocecal valve and sphincter preclude regurgitation into the ileum; the content of the small bowel, nevertheless, is forced past this check valve mechanism and in consequence a relatively short segment of bowel must bear the burden of an increased intraluminal pressure alone. Such an occlusion when complete becomes, therefore, a virtual closed loop obstruction with all its inherent dangers. Such an occlusion, though essentially a simple obstruction presenting only a block to intestinal continuity, approximates a strangulating type of obstruction in its effects upon the bowel wall. Under the motive force of systolic pressure, blood continues to find its way into the vessels of the obstructed bowel. Rises of sustained intraluminal pressure beyond the venous and capillary pressures of the vessels of the obstructed segment compel a short-lived skirmish between these two unrelenting but unequal forces; in consequence rupture of the vessels of the bowel occurs with ensuant hemorrhage, tissue necrosis, and perforation—all the evils which accompany a strangulating obstruction. In the latter, however, in addition, the loss of blood in itself may be an important item. A dog will die of hemorrhage in 4 to 5 hours when the veins of a segment of bowel 3 feet in length are tied off if blood flow through the arteries remains unimpeded (Scott and Wangensteen).

These then, in brief, are the consequences of obstruction. They point unequivocally to the importance of relieving the obstruction before irreparable damage has been done to the bowel wall. Impaired intestinal viability and increased permeability of its wall go hand in hand and open up a deadly avenue for absorption, viz., the transperitoneal route. The therapeutic problem of obstruction, therefore, should concern itself with recognizing obstruction early and instituting such remedial measures as will effectually relieve the obstruction with least hazard to the patient. Adequate replacement of fluid losses in high occlusions and of blood loss in strangulating obstructions must be indispensable requisites of intelligent and successful treatment. A sufficient daily urine output (700 to 100 cubic centimeters every 24 hours) is the best index that the fluid requirement of the tissues has been satisfied. With the knowledge that saline solution serves as a good temporary substitute for fluids lost by vomiting in upper intestinal obstructions, it is not a contradiction to say today that low obstructions are the most serious, for they carry the greatest hazard for the bowel wall. The essence of well directed therapy in low obstructions—the type most frequently observed clinically—must therefore be reduction of increased intra-

enteric pressure. Decompression or release of the obstructing agent before the viability of the bowel has become impaired will obviate damage to the bowel wall and the occurrence of transperitoneal absorption of injurious agents.

### ESTABLISHING THE PRESENCE OF OBSTRUCTION

The importance of early recognition of bowel occlusion obviously simplifies the therapeutic problem in most types of obstruction. Fortunately, most of the varieties of obstruction can be readily identified. The concurrent occurrence of intermittent cramp-like pain and borborygmus establishes the presence of *intestinal colic*. No other acute lesion of the abdomen is accompanied by so characteristic a finding. Excluding enterocolitis, food indiscretions and related conditions, the presence of *intestinal colic* when accompanied by distention indicates the presence of an intestinal block. Fundamental for the understanding of the symptomatology of obstruction is the sharp difference in the behavior of occlusions of the small and large bowel. Frequent and copious emesis usually attends the former; acute obstructions of the large intestine, even when complete, are often not accompanied by vomiting. The duodenal tube evacuates a yellowish-brown fluid from the stomach in obstructions of the small intestine; in acute obstructions of the colon the stomach is almost invariably empty and stercoraceous content is rarely recovered, except in those unusual instances of granulomas and malignancy in which spontaneous anastomoses have occurred between large and small bowel. Feces-like vomiting occurs *only* in obstructions of the small intestine.

In simple obstructions, the abdominal wall is not tender; in strangulating obstructions owing to the escape of sanguineous fluid into the peritoneal cavity and irritation of the parietal peritoneum, tenderness is uniformly elicited. A skiagram made of the abdomen with the patient lying supine indicates the extent and location of the distended intestinal coils. These findings when carefully integrated give an unmistakably clear picture of the situation. To be certain, there are types of intestinal obstruction which are notably difficult to identify correctly without recourse to exploration. In the main, however, with careful employment of the criteria here described a degree of diagnostic accuracy unsurpassed in the recognition of other acute abdominal ills can be obtained. A note of warning is in order, however, concerning the diagnosis of bowel obstruction by the roentgenologist. A good roentgen film of the abdomen is indispensable to correct and precise diagnosis, but interpretations by the roentgenologist without judicious integration of the clinical findings are likely to be frequently in error.

### THE TREATMENT

In a number of obstructions, such as strangulated hernia, volvulus, and intussusception, what must be done is quite plain. There is no alternative. Release from the strangulating agent is to be accomplished as early as possible. Only a nonviable or doubtfully viable bowel demands special consideration. In general it may be said that early operative intervention in strangulating obstructions, before anatomic changes consequent upon prolonged interference with the blood supply have occurred, permits of the obstruction being dealt with as though it were simple in nature. The only exception is thrombosis or embolism of the mesenteric vessels.

In simple obstructions, however, determination of the best therapeutic procedure is not so easily decided upon and is by no means a matter of general agreement. If the occluding agent is outside the bowel, in the nature of an adhesive band or obstructive mass, such as an ovarian cyst, division of the band or removal of the cyst will relieve the obstruction. If, however, the gut is ensnarled in a group of adhesions, or the mass is fixed and adherent to the bowel, an operation upon the bowel itself may prove to be the best manner of dealing with the obstruction. And so with intrinsic obstructions of the bowel wall, such as those caused by tumors, the question always presents itself as to whether the surgeon should content himself with relieving the obstruction or whether he should also remove the obstructing agent. The experience

of abdominal surgeons over a period exceeding half a century speaks with *emphasis* upon this point. Operations of election are hazardous in acute intestinal obstruction and can be applied with safety only to the early case. The late case of obstruction will not tolerate an operation of great magnitude. Considerable manipulation of the obstructed bowel commands much risk for the patient. Anastomotic operations in the presence of acute obstruction are decidedly unsafe. The essentials of a well planned operative procedure demand that: (1) The sterility of the peritoneal cavity be preserved inviolate. Visible spillage or contamination when operating for obstruction are synonymous with failure. The operation must be done *aseptically*. (2) The operation of least magnitude which will well undo the injurious effects of obstruction be performed. (3) That immediate restoration of intestinal continuity be a matter of secondary concern except in those instances in which intestinal fistula of itself would prove serious.

The time has come to speak of the mortality *of treatment* of acute obstruction as well as the mortality *of the disease*. Only operative procedures which have been proved to be sound in principle should be employed in the relief of obstruction. Whereas, enterostomy has been condemned as an unsafe and useless operation in obstruction, experience demonstrates that when *aseptically* done, it commands little risk and is an effective agent in decompressing the distended bowel. Except in those instances in which the obstructing mechanism is intrinsic in the bowel wall, it is usual to note frequent automatic re-establishment of intestinal continuity following catheter drainage.

Many patients with late simple obstruction, whether of the small or large bowel, may be salvaged by a prudently chosen, well executed operative procedure. I have the firm conviction that most patients with late simple obstruction whose bowel wall is viable without impaired permeability have a good chance of recovery following an *aseptic* decompression. As much cannot be said for a patient with a perforated duodenal ulcer of many hours' standing. His fate is too frequently determined by the time element alone. Facile and expert surgery do not favorably influence to any extent his chances of recovery. Advantage should be taken by the surgeon of this latitude allowed him in the surgical relief of bowel obstruction to exercise a discriminating and judicious choice of operation and to execute it with care and skill. *Aseptic* enterostomy or colostomy after the manner here shown (Fig. 2) has proved to be a safe and

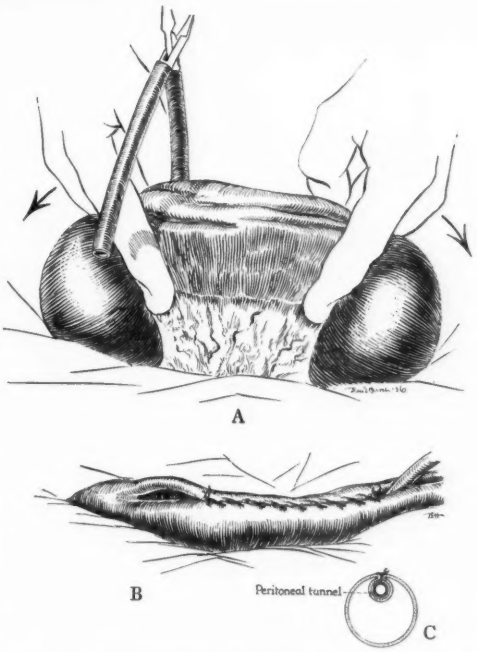


Fig. 2. The technique of an aseptic enterostomy. A, Only one loop is eviscerated—the method of collapsing the distended bowel before placement of sutures. A dilated bowel with a paper thin wall gains substance and *immediately* becomes thicker after evacuation. Before the first stitch is taken the lumen of the segregated segment should be aspirated with a needle and syringe to be certain that it is empty. B, A No. 14 (French) urethral catheter is laid upon the bowel. The catheter is anchored with a short running suture of No. 000 chromic catgut or fine silk before the gut puncture is made. C, Final peritoneal tunnel. Omentum need not be sought to cover the suture line. After removal of the rubber covered clamps, the collapsed segment upon which the enterostomy was made distends. No leakage, however, occurs. In instances in which distention is great, making closure of the abdomen difficult, the catheter may be opened at this juncture and allowed to drain through a long sterile rubber connecting tube into a bottle on the floor. Gentle pressure upon the external walls of the abdomen augments the fluid and gas escape. (Arch. Surg., 1933, 26: 933).

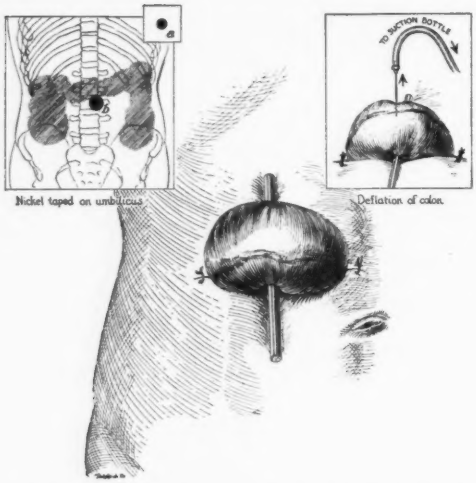


Fig. 3. Method of decompressing the obstructed colon *aseptically*. The insert on the left shows a sketch made from the skiagram of a patient with an acute occlusion of the pelvic colon due to carcinoma. The film is made with the patient lying supine and a five-cent piece is fastened over the umbilicus with adhesive tape. *a* in the insert shows the actual relative size of the coin. The distended colon is allowed to prolapse through a short transverse incision just to the right of the midline made directly over the transverse colon. A glass rod is drawn through the mesocolon and the peritoneum and anterior rectus sheath are sutured to the fatty epiploical tags of the colon. (The most medial fibers of the rectus muscle are divided and the greater portion of the muscle is pulled laterally.) On completion of the skin suture and after the protruding bowel is covered with strips of vaseline gauze, the summit of its convexity is punctured with a needle (gauge 19) attached to a suction apparatus. On several occasions as much as 2,000 cubic centimeters (largely gas) have been aspirated within a few minutes, with, of course, striking reductions in the measured intraluminal tension. After 6 to 12 hours, or whenever distention indicates it, the segment is reaspirated. After 24 hours, a small slit is made in the bowel and a catheter is inserted. This simple procedure has proved very effectual in the relief of acute obstructions of the colon and can be done with minimal risk.

(The Therapeutic Problem in Bowel Obstructions. C. C. Thomas Co., in press.)

effectual means of relieving simple intestinal occlusion in the speaker's hands. This technique of enterostomy has been previously described (24). My colleague, Dr. Vernon David, will consider in some detail the manner of dealing with the obstructed colon. I shall therefore confine my description of the surgical attack upon the obstructed colon to an illustration which depicts a method by which the operation may be done aseptically (Fig. 3).

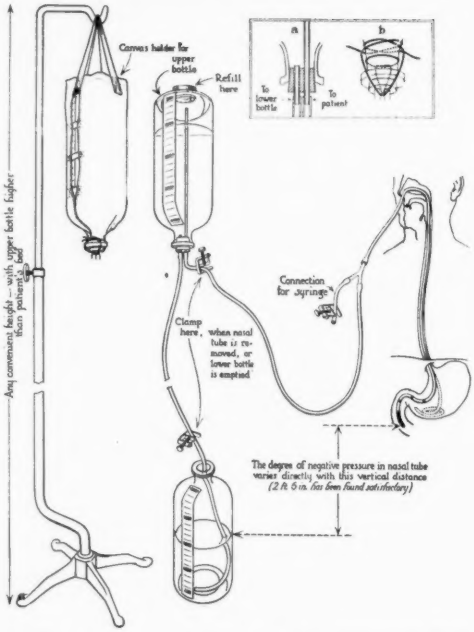
Canvas holder for upper bottle
Refill here
a
b
To lower bottle
To patient
Any convenient height — with upper bottle higher than patient's head
Connection for syringe
Clamp here, when nasal tube is removed, or lower bottle is emptied
The degree of negative pressure in nasal tube varies directly with this vertical distance
(2 ft. 6 in. has been found satisfactory)

Fig. 4. Water siphon employed in the treatment of obstruction by suction. A third bottle is always inserted into the circuit when the fluid escape is great. Liquids collected directly from the stomach and upper reaches of the intestinal canal may then be returned in part by proctoclysis.

## CONSERVATIVE DECOMPRESSION

Experience with the employment of enterostomy in the treatment of simple mechanical obstruction of the small intestine and the not infrequent early cessation of external escape of gas and fluid following the establishment of enterostomy, suggested that certain mechanical obstructions of the small intestine could be decompressed by suction applied to an inlying duodenal tube. Trial has demonstrated the verity of this impression. The value of decompression of the upper reaches of the gastro-intestinal canal in the relief of distentions of mechanical as well as paretic origin is today widely appreciated. In 1899 the late Sir Frederick Treves said, "Those who are enamoured of statistics could, I have little doubt, show that it is less dangerous to leap from the Clifton Suspension Bridge than to suffer from acute intestinal obstruction and decline operation." The experience of the

last 6 years with the application of suction to an inlying duodenal tube has adequately shown that this statement no longer holds true for certain types of obstruction.

Any principle may be misapplied to a case which it does not fit. The warning first sounded with reference to the use of suction in the treatment of strangulating obstructions as well as acute occlusion of the colon with great distention (21) bears emphasizing again. These constitute *absolute* contra-indications to the employment of suction as the single active therapeutic expedient. The practice of employing suction as a test procedure to indicate whether operation will be necessary should be discouraged. In many such instances, its employment leads only to deferment of appropriate treatment. True enough, aspiration of the stomach and the upper reaches of the bowel in every case of mechanical obstruction of the small intestine improves the status of the patient. No patient with obstruction of the small bowel should be operated upon without such preliminary evacuation. Just as a roentgenogram is indispensable in the *precise* diagnosis of obstruction, so similarly in those instances of *simple* mechanical obstruction of the small bowel in which suction is used as the principal therapeutic agent, it is mandatory that subsequent follow-up films be made to note whether decompression and restitution of intestinal continuity are actually occurring.

"Seven facts," said Mark Twain, "cannot manufacture one emotion." The value of roentgenographic findings in acute abdominal disorders when co-ordinated with critical clinical observations has been indelibly engraved upon many pages of our surgical literature for years. Yet one finds surgeons and medical men generally slow to employ the roentgenogram for purposes of orientation in acute abdominal disorders. "Acute abdomen" is not synonymous with the need for exploration. Many abdominal exploratory operations are not only unnecessary but harmful. It is fully as important to have recourse to scout films of the abdomen in obstructions and conjectured perforation of the gastro-intestinal canal as it is to check satisfactory reduction of a fracture by such means. To be certain, the information obtained from roentgenograms in acute abdominal lesions is often not as definite or final as that gained in the instance of a fracture, but decisions of the greatest moment for the safety of the patient depend upon evidence which it alone can supply. In suspected perforations and obstructions and in all borderline cases it is a valuable diagnostic adjunct. I wish that I could stir up the emotions of all the Fellows of the American College of Surgeons to a full appreciation of the importance and value of the careful integration of clinical and roentgenographic observations in the recognition of acute abdominal lesions. No hospital which essays to treat acute abdominal conditions is complete without a portable x-ray apparatus.

### LESSONS TAUGHT BY SUCTION

The employment of suction in the relief of intestinal distention has been the means of adding valuable information to our knowledge concerning abdominal disease. Most important, it has lent an absolute denial to the contention that patients with peritonitis die because of intestinal distention. Suction has been a useful agent in obviating intestinal distention in many patients with peritonitis who nevertheless succumb to their infection. The prevention or successful management of distention in the presence of peritoneal infection has not infrequently turned the tide in the patient's favor; it is nevertheless to be remembered that the patient with peritonitis must fight out the battle of infection alone with no specific help from remedial resources now available. This knowledge indicates the futility of enterostomy as well as of the much more formidable and irrational procedure of enterocolostomy (Handley) in peritonitis. Experience with suction has also taught that the nausea and vomiting of mechanical and physiological obstructions are due essentially to gastric and upper intestinal retention. Evacuation of the stomach and upper intestinal reaches by continuous suction obviates the occurrence of such vomiting. The frequent use of suction after abdominal operations to prevent intestinal distention has lessened considerably the incidence of post-operative mechanical obstructions. The scope

of the conservative management of many acute lesions of the abdomen has been widened by the knowledge that suction is an effectual agent in dealing with intestinal distention.

## CONCLUSIONS

The hazards of obstruction are:

1. In high occlusions, loss of essential electrolytes and fluids by vomiting.

2. In low obstructions, damage to the bowel wall, through the agency of increased intraluminal pressure with increased permeability and ultimate migration of bacteria and other noxious agents through its wall, or actual rupture of the wall.

3. In strangulating obstructions, in addition to the effects of intestinal block occasioned by the level of the obstruction, the threat to the viability of the bowel wall is acute; also the blood loss may be great.

These occurrences demand:

1. Reparation of the loss of electrolytes and fluid by the liberal para-oral administration of saline solution (intravenously).

2. Replacement of loss of blood in strangulating obstructions by transfusion.

3. Release of the obstructing agent or reduction of increased intra-enteric pressure by decompression before the viability of the bowel wall is impaired.

The operative procedure of least magnitude which will accomplish the desired end, when executed *aseptically*, promises the patient who is ill with bowel obstruction the best chance for recovery. Release of the constricting mechanism is essential in all strangulating obstructions. Decompression is the *keynote* of successful treatment of all late simple obstructions; only in early simple obstructions can deliberate search for, and release from, the obstructing agent be made without pyramiding the risk. A better understanding of the effects of obstruction and an appreciation of how their consequences may be most directly avoided should lead to a general lowering of the mortality from the disease.

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# CHRONIC INTESTINAL OBSTRUCTION DUE TO LESIONS OF THE LARGE BOWEL

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SUBACUTE or chronic obstruction of the colon is more commonly observed than acute obstruction of the colon due to the relative frequency of lesions occurring in the large bowel which are slowly progressive and therefore obstruct the bowel gradually. Cancer of the colon stands first as a causative factor, with diverticulitis and ulcerative colitis appearing as occasional factors. More rarely occurring lesions causing obstruction are acquired and congenital strictures of the rectum, Hirschsprung's disease, chronic granulomatous lesions, endometriosis, and benign polypoid tumors of the colon.

Acute obstruction of the colon develops when any of the above factors completely occlude the bowel, or in uncommon conditions, such as congenital atresia of the rectum, volvulus of redundant sigmoid or cecum, intussusception of a polypoid or cancerous tumor of the transverse colon or sigmoid, or strangulation of the colon in a sliding hernia or diaphragmatic hernia.

Paralytic ileus from peritonitis affecting both the small and large bowel is perhaps in a category peculiar to itself.

The clinical picture of large bowel obstruction varies considerably from ileus of the small bowel in that the symptoms of obstruction develop slowly and in that distention is more pronounced and diffuse while vomiting appears later, is less violent, and only becomes fecal when the small bowel eventually becomes dilated. These facts are well demonstrated when purposeful obstruction of the large bowel is produced surgically, as in the formation of an end colostomy which is kept closed for several days. When this surgical procedure has been carried out in a pre-operatively well deflated and emptied bowel, the patient rarely has symptoms during the first 24 hours. On the second day slight distention and cramps develop from hyperperistalsis, but usually not until the third day does the patient become greatly distended and begin to hiccough or vomit. This purposeful complete obstruction of the colon acts much differently if performed on a bowel already partially obstructed and containing an excess of feces and gas, for, under such conditions, there is a stormy development of distention, vomiting, and toxemia. It is also obvious that the nearer the obstruction of the colon is to the cecum, the more the picture resembles small bowel obstruction.

In chronic obstruction of the colon due to cancer the symptoms may be so slight as to escape the notice of any but an alert patient. Trifling change of bowel habits, with slight constipation or occasional diarrhea, more gas formation with gurgling or occasional bleeding or abdominal cramps, may be the only symptoms at the onset. A little later chronic distention of the colon may be seen in a flat roentgenogram of the abdomen revealing the haustrated dilated colon. Due to repeated effort on the part of the musculature of the colon to push bowel contents past an obstruction, the bowel wall may become greatly hypertrophied. Listening to the peristaltic sounds with a stethoscope on the abdominal wall may call the examining physician's attention to the hyperperistalsis and to its point of greatest intensity. Peristaltic waves may also be visible through a thin abdominal wall. In the continuing development of this chronic obstruction, the large bowel above the lesion may become 4 to 6 inches in diameter and contain enormous amounts of feces without actually being acutely obstructed, and the patient may eat and drink with only occasional vomiting. Eventually the small bowel shares in the distention and complete obstruction may supervene. If the cancer of the colon develops in the normally narrowed portions of the bowel, as the rectosigmoid and the flexures of

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Chronic obstruction of the colon showing marked haustration of the colon due to gas dilatation.

Fig. 2. Filling defect of the sigmoid due to carcinoma showing double hook-like deformity at the site of the ulcer.

Fig. 3. Filling defect in sigmoid loop due to diverticulosis of the sigmoid.

the colon, the symptoms of obstruction develop easily and more acutely, whereas cancer developing in the ampulla of the rectum and cecum may exist for months without any symptoms of obstruction. It usually requires a year for a cancer of the ampulla of the rectum to encircle the bowel completely. If chronic obstruction of the large bowel from cancer is suspected, it is very important, in arriving at a diagnosis, to avoid filling the colon with barium *above* the obstruction or of giving barium by mouth, either of which procedures may convert a partial obstruction into a complete one. Careful administration of an enema of barium will indicate the point of obstruction and will show the sharp hook-like defect in the bowel.

When the point of obstruction is localized, the problem then to consider is how to deflate and empty the bowel above the obstruction so that an operation for the removal of the growth may be carried out without preliminary colostomy. This may frequently be accomplished by administration of a non-residue diet, repeated and slowly given warm saline enemas, heat to the abdomen, and mineral oil by mouth. If distention and cramps continue or a flat roentgenogram of the abdomen shows a dilated gas filled colon, it is then much safer to carry out a preliminary operation for decompression of the bowel above the obstructing lesion. If the growth is at the rectosigmoid, we prefer to make a transverse colon colostomy so that the radical removal of the growth at another time will not be complicated by a fecal fistula in or near the operative field. If the growth is in the descending colon or splenic flexure, a colostomy is made on the left side of the abdomen in the transverse colon near the hepatic flexure. If the growth is in the transverse colon or hepatic flexure, a cecostomy is performed, but if the growth is in the cecum, it is usually better to make a side-to-side anastomosis of the terminal ileum and transverse colon as this will serve as a preliminary stage in the secondary removal of the right half of the colon at another time. When the growth lies in the cecum, transverse colon, splenic flexure, descending colon, or proximal point of the sigmoid and the obstruction is slight, it is good policy to examine the liver at the time of the decompression operation. If it contains carcinoma or the growth is inoperable due to local spread, a sidetracking operation may then be done, anastomosing, for example, the transverse colon to the sigmoid in an inoperable cancer of the splenic flexure. Under no circumstances should a radical operation for removal of cancer of the rectum or colon be carried out in even a slight degree of obstruction, as peritonitis develops easily and more frequently. Even sidetracking operations are not advisable in any considerable degree of obstruction.

Fig. 4. Obstruction foreshortening and deformity of the colon due to chronic ulcerative colitis. The area filled represents the whole colon.

Fig. 5. Megacolon in an infant due to congenital stricture of the rectum. The findings and course resemble Hirschsprung's disease.

In acute obstruction of the colon with marked distention and a feces loaded bowel, it is usually the safest procedure to avoid exploration of the abdomen and to place a Pezzar catheter into the cecum through a muscle splitting incision. A portion of the cecum is delivered through the wound, which is then closed about it, the edges of the wound are protected by vaseline or zinc oxide gauze, and the catheter is then inserted into the bowel and the bowel is closed about it with a purse string suture. The end of the catheter is led into a bottle outside of the operative field.

All the symptoms of chronic obstruction of the bowel may be present in diverticulitis of the sigmoid loop in which spasm of the bowel results in distention, irregularity of bowel habits, and cramp-like pains. These symptoms usually come in attacks and may be alleviated by proper diet, heat to the abdomen, and administration of tincture of belladonna. If the inflammation of numerous diverticula becomes pronounced, a diffuse inflammation of the bowel results with consequent fibrosis of the bowel and organic narrowing. This is not of common occurrence but is occasionally seen affecting the region of the rectosigmoid or, more rarely, the whole sigmoid loop and descending colon. Over a period of months definite and progressive symptoms of obstruction develop and it becomes necessary to do a temporary colostomy in the transverse colon to put the affected loop of bowel at rest. After an interval of 6 months to a year the colostomy may be closed, if by fluoroscopic examination the affected bowel is seen to return to a relatively normal pattern. Rarely should one resort to a resection of the affected bowel.

Severe ulcerative colitis of the idiopathic type commonly deforms the bowel by markedly foreshortening it, so that the splenic and hepatic flexures are lost, and at the same time materially constricts the lumen of the bowel by contraction of scar tissue in nature's effort to heal the process. This may result in unyielding strictures of an annular or tubular character which produce all the symptoms of chronic large bowel obstruction. This condition, sad to say, is best treated by a permanent ileostomy.

Acquired strictures of the rectum due to advanced lymphogranulomatosis inguinale not infrequently lead to chronic bowel obstruction by reason of tubulation of the entire rectum up to the rectosigmoid junction. The process may go on to complete obliteration of the bowel. This obstruction is best treated by a permanent left sided colostomy as the process is almost always limited to the rectum.

An unusual and often unrecognized cause of chronic obstruction of the colon is due to congenital stricture of the rectum. In embryonic life the descending mesenteron or hind gut meets the infolding cutaneous proctodeum and a membrane at the site of their union at the mucocutaneous line of the rectum usually disappears. In the cases under consideration, the membrane persists in part so that a diaphragm

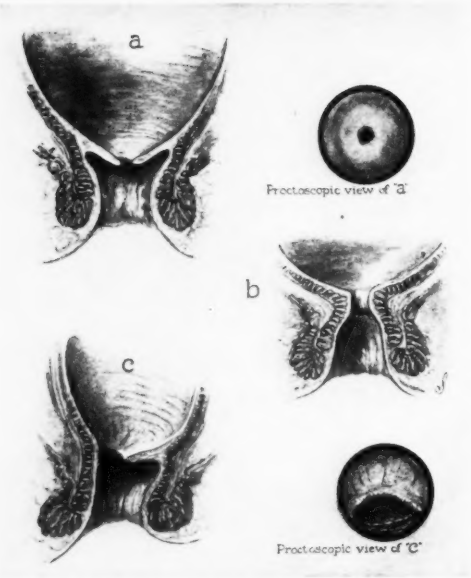


Fig. 6. Different types of congenital stricture of the rectum. a, Iris type; b, tubular stricture; c, sickle-shaped diaphragm.

with a 2 to 4 millimeter opening in the center or a half moon sickle shaped diaphragm persists which greatly interferes with the passage of bowel contents. This results in intestinal stasis with distention of the colon with feces and gas and the symptoms of chronic obstruction of the bowel. If the condition is not recognized in infancy or childhood, it may persist into adult life with resultant persistent partial obstruction. We have reported several instances of megacolon from this cause occurring in childhood where the whole abdomen was filled with an enormous feces loaded large bowel. In infancy or childhood these diaphragmatic strictures can usually be broken down by dilatation, but if not, a longitudinal division and a transverse suture can be accomplished and the narrowing overcome. In adult life some such plastic operation is always necessary.

The most dangerous and difficult type of ileus to treat is the paralytic type, which affects both the large and small bowel. The problem concerns itself with the cessation of the normal motions of the bowel and the absorption of toxic products from the lumen of the bowel. The vagus motor and intrinsic motor mechanisms of Meissner and Auerbach are easily put out of action by the inhibitory nerves of the splanchnic plexus. Experimental irritation of the peritoneum in animals by injection of weak iodine or turpentine solutions results in a reflex inhibition of bowel motions by stimulation of the splanchnic nerves which may last 2 to 3 days. If the splanchnic inhibitory nerves are paralyzed in such an experiment by lumbar or spinal anesthesia, bowel function is usually restored at once. If we regard the matter clinically, we appreciate the fact that prolonged intraperitoneal surgical procedures or the irritation of the peritoneum by infection results at once in a reflex inhibition of intestinal motions. This results in distention and accumulation of fluid in the bowel which may be absorbed into the circulation and cause toxic symptoms. If peritonitis is present, the inflamed loops of bowel continue to be inactive by reason of direct damage of the motor nerves in the bowel wall. This causes distention and absorption of toxic products and the bowel contents begin to back up into the stomach. The effect of inflammation of a loop of bowel on abolishing motion in it can be shown experimentally and clinically. The clinical performance of a colostomy or ileostomy has a striking effect on the intestinal motion in the loop brought out on the abdomen. In 24 hours such a loop of bowel is distended, thickened, and covered with fibrin. It can be pinched, touched with a cautery, or stimulated with an electrode without producing peristaltic motion in most instances. However, as weeks go by, the extruded bowel loses its inflammation and appears normal and peristaltic motions return. It seems reasonable to assume, therefore, that in paralytic ileus from peritonitis we have loops of bowels in which paralysis has occurred both by reflex inhibition of motion and by reason of direct damage by inflammation of the motor nerve endings in the bowel wall. This results in distention, stasis, and absorption of toxic intestinal contents. The rational treatment of paralytic ileus from peritonitis then becomes symptomatic in that we must decompress the bowel as much as possible by keeping the stomach

empty by the admirable apparatus described by Wangensteen, and at the same time replace into the circulation an adequate amount of salt solution by venoclysis and subcutaneous injection. Morphine by hypodermic injection stimulates peristalsis if the bowel is not too badly damaged. The outcome, under such conditions, depends very largely on the continuity and severity of the peritoneal infection. If no open source of contamination of the peritoneum exists and the process tends to limit itself, many of these patients will gradually recover and peritoneal peristalsis will again be re-established.

## Discussion

DR. I. S. RAVDIN, Philadelphia: The excellent papers which Drs. Wangensteen and David have just presented are indeed timeworthy. Dr. Wangensteen has justly said, "Philosophy or theory without the support of experiment or demonstration is untrustworthy." One may even go a step farther and say that experiment without demonstration may at times prove unreliable. For too often high hopes have been raised that the problems of acute intestinal obstruction have been solved, only to be destroyed by the finding that experiment and practice do not always go hand in hand. In the final analysis the findings of the investigator, if they are of real value, should be expressed in a better understanding of the processes involved in a given reaction and should lead eventually to a reduction in the morbidity and mortality of the disease.

An understanding of the profound disturbances produced by the loss of water and electrolytes, and frequently of the serum protein, in certain of the acute obstructions of the small intestine is of the greatest importance in the pre-operative preparation and postoperative care of the patient with obstruction. It must be admitted, however, that in the majority of cases of acute obstruction involving the small bowel, the lesion is in the lower reaches of the small intestine where the alterations in fluid and salt balance do not make their appearance early and are not very marked in character. The high hopes of those who believed that striking results were to be obtained by the administration of sodium chloride were not to be realized in many of these cases.

The investigations of Herrin and Meek, Wangensteen, and others on the part which mechanical factors play in acute intestinal obstruction have had the important effect of pointing out to us that the problem is a complex one which cannot be solved by a single approach. The effects of bowel distention on the muscular coats of the intestine, on fluid accumulation, on the interference with adequate vascular circulation of the bowel wall, and on the maintenance of a normal blood volume, are of such a nature as to produce the most severe physiological changes in the patient. Further study is needed of the pathological physiology which distention of the large and small intestine produces, for although distention of the colon may be very marked, the course of the disease is not nearly so fulminating as when the obstruction is higher in the intestinal tract. It is fortunate that the ileocecal valve is often incompetent so that the passage of gas and fluid into the small intestine prevents the short closed loop obstruction which Dr. Wangensteen described.

While in acute obstruction of the large bowel vomiting is not so frequent or profuse as in obstruction of even the lowest portion of the small bowel, our experience is similar to Dr. David's in that it is observed and may in the later stages of large bowel obstruction be fecal in type. If the obstruction is sudden in onset, the response may at times be a violent one.

In our own experience the use of the conservative method of suction drainage, which Dr. Wangensteen and his associates have done so much to popularize, has been of the utmost advantage in the pre-operative and postoperative care of patients with obstruction of the small bowel. If suction drainage can be properly instituted, and gangrene is not suspected, this method of therapy helps to take certain of these cases from the category of emergency surgical operations, and permits us to operate at a time when the patient is better able to withstand surgical intervention.

Dr. David has portrayed for you the vagaries of the clinical picture and the insidiousness of the onset of chronic obstructing lesions of the large bowel. The progress of the malignant obstructing lesions of the large bowel is often so slow, and the symptoms which they cause are so elusive, that they may escape even the alert patient.

Perhaps very few of you have operated upon a patient for acute obstruction of the cecum or ascending colon. The malignant lesions of this portion of the bowel are rarely annular and constricting and the fecal current is still fluid. The constricting lesions of the colon are found in that portion of the large bowel where the fecal mass has been subjected to physiological dehydration.

The importance of primary decompression operations in cancer of the large bowel should continue to be stressed. These procedures add to the safety of the secondary and major operation and to the comfort of the patient.

The possession of good diagnostic acumen, of sound judgment, and of knowledge of the problems which confront one in the pre-operative and postoperative period is of primary importance in relation to morbidity and mortality in these conditions. John B. Deaver was wont to say, "It is better to look

forward to two operations and a live patient than one operation and a dead patient." In no group of lesions is this aphorism more applicable than to the group found in acute or chronic obstruction of the intestinal tract.

Dr. Thomas A. Shallow, Philadelphia. I know of no contribution to surgery in recent years which eclipses the Wangensteen principle of decompression. It has added to the operative safety of patients with acute intestinal obstruction and to the postoperative comfort of patients without intestinal obstruction to such a degree that it has now replaced all methods used in the past.

Many years ago, it was said by Mayo that the stomach tube is to the surgical resident what the stethoscope is to the medical resident. How truly is this fact impressed upon us when we see the effect of the continuous use of the duodenal tube by the Wangensteen apparatus.

The most serious problem which confronts the abdominal surgeon today is the distended abdomen associated with acute intestinal obstruction. Even in the hands of the most skillful surgeon or the best technician, the distended abdomen in acute intestinal obstruction is a nightmare. In the past, all of us have attempted to fight our way across the pushing coils of intestines to isolate, diagnose, and release the cause of obstruction. In our effort, we produced shock and we traumatized tissue to such a degree that even in successfully performed operations, a fatality occurred. It might be said that we entered the abdomen in the state of storm to launch our surgical ship into its depths. The introduction of the Wangensteen decompression principle has made it possible for us to enter the abdomen in a calm and to carry the individual through the storm without the danger of gangrene, rupture, or permeation of the bowel. It has made it possible for us to reach the area of obstruction under direct vision and with proper exposure, then to exercise our surgical skill and judgment in overcoming the obstructing agent. All of these surgical principles have been accomplished after due consideration of the physiological factors and the pathological processes which exist, so that the operative delay has not been deleterious to the patient. Dr. Wangensteen has clearly shown that the permeability of the intestinal wall, the rupture of the vessels, and the development of gangrene all pass through stages of circulatory dysfunction. This begins with a gradual increase in pressure in the capillaries and ends when the intramural intestinal pressure exceeds that of the systolic vascular pressure. He establishes beyond question that rupture, permeability, and gangrene can be prevented by decreasing the intramural intestinal pressure and, at the same time, by evacuating the swallowed air and the intestinal content, thus relieving abdominal distention and preparing the patient for safe surgical treatment.

While Dr. Wangensteen does not make any claim for the cure of peritonitis by means of this method of treatment, I am strongly of the belief that many patients with peritonitis are made exceedingly comfortable, and that the balance is cast in favor of a certain number of this group by the use of the decompression mechanism. It certainly answers the problems of splinting the bowel and of putting the bowel absolutely at rest, a procedure which was so strongly urged by the older authorities in the treatment of peritonitis. In their day, they used large doses of morphine. Now, we remove the stimulus of the obstructing agent.

Dr. David's paper dealing with obstructive lesions of the large intestine is very comprehensive. The keynote of this paper is the determination of the etiology of the obstructing lesion and its location.

He has stressed the various diagnostic means for determining the location and the character of the lesion. The sigmoidoscope and the proctoscope are invaluable in determining and differentiating inflammatory lesions from carcinoma, and even digital examination of the rectum will disclose many causes for chronic obstruction.

Here, contrary to obstruction in the small bowel, roentgenograms are conclusive in localizing the site of the obstruction, in determining the degree of obstruction, and in differentiating inflammatory from neoplastic disorders. Too much cannot be said concerning accuracy in diagnosing large bowel lesions.

Dr. David has struck the keynote of warning concerning the risks and the dangers in primary operative procedures in large bowel obstruction. Indeed, it might be said that primary decompression by cecostomy and colostomy, even in subacute obstructive lesions, is just as important as the Wangensteen decompression method in lesions of the small bowel.

We all know that even in the most skilled hands, sidetracking operations in large bowel obstructions are attended with a relatively high degree of mortality and that the occasional operator's attempt to perform sidetracking operations or anastomosis in the presence of obstruction is fraught with almost certain fatality. It follows, therefore, that the stage resection procedure for large bowel obstructions, particularly in malignancy, offers the best opportunity for a cure.

# TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY INTERNAL FIXATION

M. N. SMITH-PETERSEN, M.D., Boston, Massachusetts

IN 1931 a method of internal fixation of fractures of the neck of the femur by means of a flanged nail was published by the author. A series of 24 cases treated over a period of 6 years was reported. This trial period was deemed sufficient to justify publication of experience gained and results obtained. A new method of treatment is never perfect at the time of its inception but it improves as errors are eliminated; at the time of the publication we did not feel that the method of introducing the nail had been perfected since it was an extensive procedure, requiring wide experience with hip joint surgery; this necessarily limited its usefulness. Results obtained, however, were far superior to those obtained by other methods in our clinic.

After publication we continued the open reduction because the operative findings were such that closed reduction seemed doomed to failure in many cases. Interposition of synovia, capsule or fragments of bone was interpreted as a barrier to bony union. Later developments proved us to be wrong in this conclusion. Apparently the principle of the nail appealed to surgeons in different parts of the world but not the method of insertion. Modifications, simplifying the surgical procedure, soon appeared in the literature and excellent results were reported.

Wescott of Roanoke, Virginia, advocated closed reduction, followed by nailing through subtrochanteric incision, using protractors and anteroposterior x-ray films to guide the course of the nail. He reported a very successful series. Johansson of Gothenburg, Sweden, introduced a centrally cannulated nail which was threaded over a Kirschner wire introduced under roentgenographic control by means of a rather complex instrument of precision. Again a series of excellent results was reported. King of Melbourne, Australia, independently of Johansson, proposed the use of a centrally cannulated nail, two wire guides being introduced under the fluoroscope. He also reported a successful series. The interesting point about these three pioneers in the field of closed reduction, followed by nailing through a small lateral incision, is that they all depended upon roentgenographic control. It is my feeling that they all came under the influence of the contribution of Leonard and George who introduced the curved cassette for the purpose of taking lateral roentgenograms of the hip. Even though the curved cassette has been shown to be unnecessary, credit goes to them for calling attention to the value of lateral roentgenograms of the hip in the treatment of fractures of this joint. In view of their success with the closed reduction, the theoretical objections, such as interposed structures, must be set aside.

Many other modifications have appeared during this 5 year period; the aim in general has been to render the introduction of the flanged nail less complex and, therefore, available to a greater number.

From the Orthopedic Service, Massachusetts General Hospital and Harvard Medical School.

Presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

## THE NAIL

The nail (Fig. 1) seemed an ideal means of fixation; it displaced a minimum amount of bone and effectively prevented motion in all planes. However, substitutes for the nail, in the form of wires, pins, screws and bolts soon appeared; their method of introduction was said to be simple, they apparently immobilized the fracture, and good results were reported. No procedure for internal fixation of fractures of the neck of the femur should be termed "simple"; it may appear so to the originator, but the novice will always find it complex. As to their efficiency: The mechanical principle of the nail is sound, more sound than that of any of the substitutes.

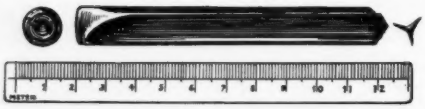

Fig. 1. The three-flanged nail as now used. Wescott first suggested that the nail be made in one piece. King introduced the screw thread in the head for the extractor; White applied the same to the one-piece nail.

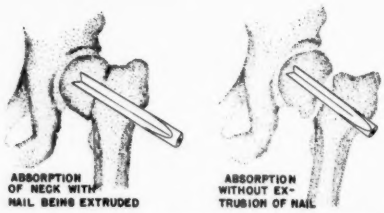


Fig. 2. Diagrammatic representation of absorption of the neck with extrusion of the nail. Left, fragments kept in apposition; right, the same without extrusion of the nail—fragments held apart.

As to the good results reported: Bony union in fractures of the neck of the femur sometimes does not occur for a year or even more than a year. Roentgenographic evidence in this respect is unreliable. There is little or no external callus, and the amount of internal callus is difficult to estimate; more than once have we interpreted roentgenograms as showing bony union, withdrawn the nail, and obtained nonunion. In 2 cases this occurred over a year following operation. In view of this experience I have become skeptical of any roentgenographic interpretation of "bony union" in a few weeks to a few months. Any report, then, which is based on cases of less than 2 years' duration must be referred to as a preliminary report, not a report of end-results. Until we have reports on true end-results we are unable to accept wires, pins, screws, and bolts.

The serious objection to the nail has been raised that it "slips out" or becomes extruded into the soft parts in the subtrochanteric region (Fig. 2). One reason for this is that the surgeon commits the error of sacrificing the full thickness of cortex at the point of insertion of the nail. The same is apt to happen if the head of the nail is driven into the cortex, depressing it into the medulla. If the cortex is left intact and the starter properly used, this is much less apt to happen because the flanges of the nail are then gripped by the cortex. Even so, the nail is sometimes extruded, but only in the presence of absorption of the neck. In these cases this "objection" becomes an advantage, because it allows the head to stay in contact with the remains of the neck until union takes place; if the nail were not extruded, the fragments would be held apart and nonunion would result.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 3. Case of 19 months' nonunion. Partial aseptic necrosis. Slight absorption of neck.

Fig. 4. Same as Figure 3 after nailing. Nail low, but good relationship between head and neck.

Fig. 5. Same as Figure 4 after extraction of nail, 3 years after its insertion. The roentgenogram shows the thinning of the joint cartilage and mild hypertrophic changes.

### SHOULD THE OPEN REDUCTION BE ABANDONED?

After publication of the first 24 cases, encouraged by our results, we continued using the open reduction in 26 more cases. The results were not quite so good as in the original series: In only 70 per cent was bony union obtained, although function was most satisfactory. In the total series of 50 cases, 12 were old, ununited fractures at the time of operation; duration of nonunion varied from 6 to 24 months. In 9 or 75 per cent of these, bony union with excellent function was obtained by open reduction and nailing. The average age was 45 years, considerably younger than in the fresh fracture cases. Just one case is reported to illustrate this series:

A young woman of 32 years entered the hospital with an ununited fracture of the neck of the femur of 19 months' standing. Roentgenograms showed a relatively dense head (Fig. 3), but there were areas apparently undergoing Phemister's "creeping substitution"; there was slight absorption of the neck. Open reduction (Fig. 4) with nailing was done; slight bleeding from the head, good bleeding from the neck. The nail was low but good relationship between the head and distal neck was obtained. After 8 weeks' recumbency, with extremity suspended, the patient was allowed up in a leather spica; crutches with increasing weight bearing were used for 8 months, followed by a cane. The nail was removed 12 months after operation. Roentgenogram 3 years later showed slight thinning of joint cartilage and mild hypertrophic changes (Fig. 5); at this time there was no pain and the function was excellent.

In cases of nonunion, without absorption of the neck, the open reduction is necessary in order to remove scar tissue and to freshen fracture surfaces; the nailing procedure is justified by the results obtained in a relatively high percentage of cases. The operation is extremely difficult and lengthy; it should not be undertaken in the aged.

Watson-Jones of Liverpool, England, is using a lateral approach with exposure of the fracture, followed by nailing (Fig. 6). This is distinctly less of a surgical procedure than the supra-articular, subperiosteal approach. He reports 91 per cent of bony union in a series of 35 cases. Any method as successful as this surely deserves consideration, in spite of the fact that it involves fairly extensive surgery.

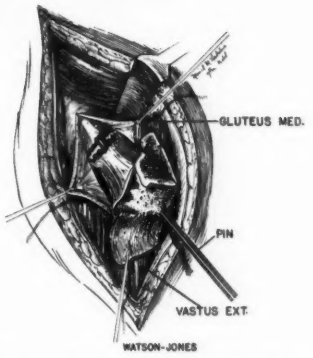


Fig. 6. Watson-Jones' open reduction through lateral approach. Involves more of a surgical procedure than is apparent from this diagram.

### PRESENT TECHNIQUE OF INSERTING NAIL

The procedure used in our clinic at the present time is a combination of the technique as published by Wescott, by Thornton and Sandison, and by White. There is no emergency about the operative procedure; the patient can be made comfortable by suspension of the affected extremity with 5 to 10 pounds of traction. There is very commonly a mild temperature reaction to the injury and resulting hematoma; the temperature runs between 99 and 100 degrees. Thorough physical examination, accompanied by the usual clinical laboratory tests, should always precede the operation; on the basis of such an examination the anesthesia is decided—local, spinal, or general.

Either preceding the operation or as a first step in the operating room, a roentgenogram is taken of the unaffected side with a measuring rod strapped to the skin over the greater trochanter as suggested by Wescott and Watson-Jones. This gives a means of determining the exact length of the nail (Figs. 7 and 8).

The method of reduction is essentially that advocated by Leadbetter. There is little difficulty experienced in reducing the fracture; adduction, external rotation, lateral traction and various other maneuvers have been advocated in order to "unlock" the fragments; in our early experience with open reductions we thought these maneuvers helpful, but as

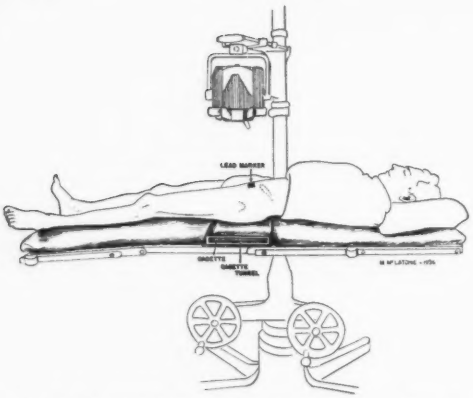

Fig. 7. Characteristic position of extremity before reduction, distal fragment externally rotated, consequently foot in eversion.

Fig. 8. Unaffected extremity in position before affected side is manipulated.

time went on we learned that traction in flexion followed by internal rotation, abduction and extension is most satisfactory in reducing the fracture. My personal method (Fig. 9) of applying traction in flexion is to place my forearm under the leg of the affected side with the knee in flexion; the other hand is placed on the patient's pelvis, the thumb just below the anterior superior spine, fingers under the trochanter. Before applying traction, the arm which is exerting countertraction is held with the elbow flexed; as traction is applied, the elbow is extended and the body is straightened. These two maneuvers, extending the elbow and extending the hips, furnish all the traction that is necessary. The traction maneuver is followed by internal rotation, abduction, and extension; these three motions are performed practically simultaneously, at least one follows the other so closely that it would be misleading to say that one takes place independently of the

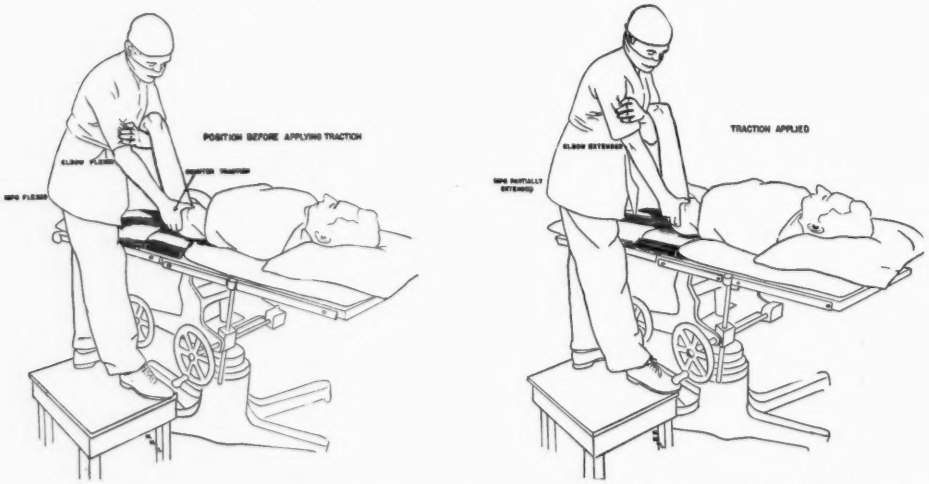


Fig. 9. Diagrammatic representation of application of traction in flexion of 60 to 90 degrees. Note position of elbows and hips of surgeon before and after application of traction.

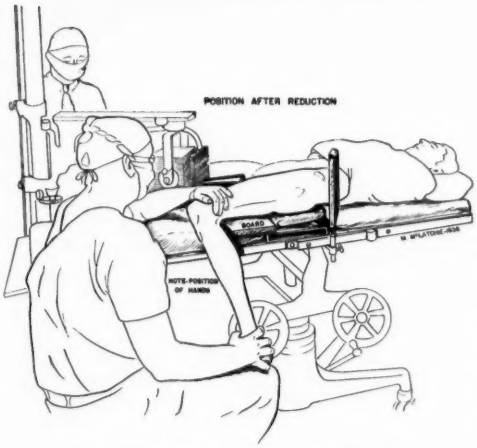


Fig. 10. Position after reduction: Hip internally rotated 20 degrees, abducted 25 degrees, and extended so that shaft of femur is parallel with the table. Knee flexed to 90 degrees or more, thereby rendering the rectus femoris taut, resulting in close apposition of fragments.

other. With the hip extended (Fig. 10) so that the shaft of the femur is parallel with the surface of the table, an assistant maintains this position by holding the extremity with the knee flexed at 90 degrees or more; internal rotation of the hip approximately 20 degrees and abduction of about 25 degrees are carried out. This is a very secure position; with the knee flexed at 90 degrees or more and the hip abducted and internally rotated, the rectus femoris is relatively taut, thereby aiding in the apposition of the fracture surfaces. If the hip were in the adducted and externally rotated position, flexing the knee would tend to do just the opposite, namely, displace the distal fragment upward. Thornton advocates the use of a board underneath both thighs just proximal to the flexed knee joints; this is a distinct help in maintaining the position. Roentgenograms are now taken in the anteroposterior and lateral planes; if the reduction is not satisfactory, the entire procedure is repeated.

A satisfactory reduction does not necessarily mean an anatomical reduction; a slight valgus position of the head is to be desired because it represents a stable relationship for transmission of weight bearing (Fig. 11). It

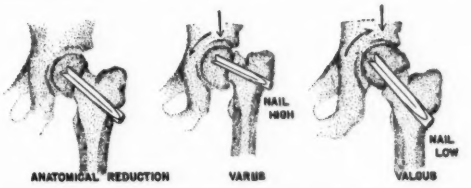


Fig. 11. Diagrammatic representation of fragments after reduction. Anatomical and valgus positions favorable. Varus position should not be accepted. Note effect of weight transmission (arrows) in the different positions.

should be remembered, however, that if the head does go into valgus, the nail should be started lower in the subtrochanteric region in order to strike the center of the head. A varus position of the head is to be avoided; it represents an unstable position which does not stand up under weight bearing. Rotation of the head, either anteriorly or posteriorly, should not be accepted, since they both will result in limitation of hip motion.

Having obtained a satisfactory reduction, an incision (Fig. 12) 4 to 6 inches long is made over the trochanter, extending downward parallel with the shaft of the femur. Exposure of the lateral aspect of the trochanter is necessary in order that the superior attachment of the vastus externus to the inferior border of the trochanter may be defined. The vastus externus is reflected subperiosteally, exposing the subtrochanteric region. The central axis of the neck corresponds to a point three-fourths of an inch to one inch below the ridge representing the superior attachment of this muscle. At this point the nail starter is driven

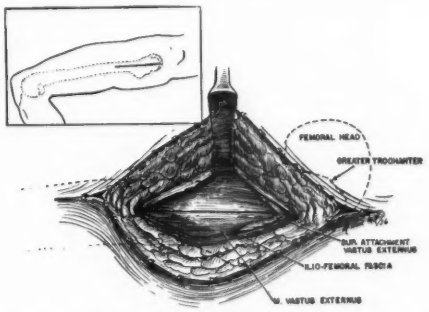


Fig. 12. Incision and exposure of vastus externus. Note superior attachment of the vastus externus. It is an important landmark.

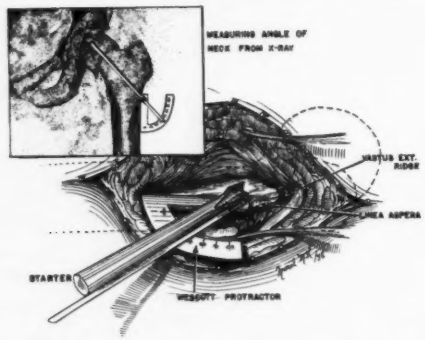


Fig. 13. Use of Wescott protractors. Insert shows method of measuring angle from roentgenogram. Note also the use of the protractor for directing the starter.

in at an angle previously determined by means of a protractor from the roentgenogram taken after reduction (Fig. 13). Wescott first described this method of directing the course of the nail from the subtrochanteric region.

The nail starter is intended for the purpose of going through the cortex without dulling the edges of the nail; it is advisable to direct it in the correct course. As soon as the starter has penetrated the cortex, it is removed and the nail is inserted in its place; again the direction of the nail with the lateral aspect of the femur is usually between 40 and 50 degrees (Fig. 14). The nail is now driven in, it is kept in the horizontal plane unless the lateral roentgenogram shows that the neck of the femur deviates from this plane; if it does, proper correction is made. As the nail enters the medulla, if it is correctly directed, it will enter the central axis of the neck with

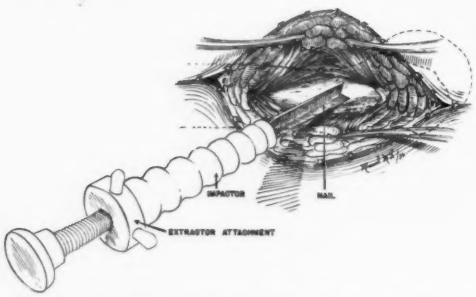


Fig. 15. The White impactor and extractor attachment in position.

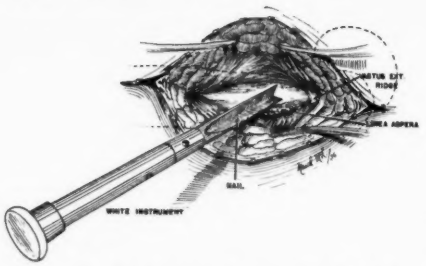


Fig. 14. The White extension screwed into the head of the nail; the nail has been started on its course.

very little resistance. If it is found that there is resistance to the progress of the nail, roentgenograms should be taken, since resistance usually indicates that the course of the nail is incorrect and that it is striking either the superior or inferior cortex of the neck. Roentgenograms taken at this time, then, will decide whether the aim is right; if there is any question about its being correct, the nail should be withdrawn and started in the corrected direction. It is at this point that White's instrument is particularly valuable (Fig. 15); in the past we have found it extremely difficult to extract the nail once it was started on its course. With White's instrument it is very easily extracted and started over again. This instrument also serves as an extension to the nail and facilitates aiming it in the right direction.

With the hip in the abducted position the central axis of the neck of the femur intersects the femoral artery as it passes under Poupart's ligament. A lead marker placed at this point is helpful in directing the nail; I use both the protractor and the lead marker, checking one against the other.

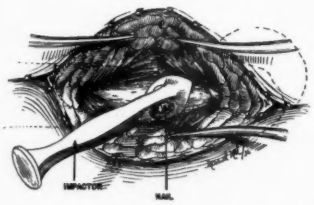


Fig. 16. The nail has been driven home; the author's impactor in position. Impaction should not be overdone, but should bring about apposition and interlocking of fragments.

After the nail has been driven home, anteroposterior and lateral roentgenograms are taken. If these are satisfactory, the fracture is gently impacted (Fig. 16); I still feel that impaction is important in apposing and interlocking the fragments, but it should not be overdone.

Teamwork is essential in any method depending upon radiographic control of the course of the nail. Faulty x-ray technique means loss of time and loss of the surgeon's temper. This is particularly true in the method outlined, which requires the use of one portable x-ray unit only; this means shifting of the x-ray machine for the anteroposterior and lateral films which increases the chance of error. Relatively few hospitals can boast of two portable units, however; such equipment increases technical accuracy and greatly facilitates the introduction of the nail.

As already stated, many methods have been developed for closed reduction, followed by lateral nailing; the surgeon must select the one that appeals to him the most and visualize every step before he undertakes it. Our own experience with this method is limited to less than 20 cases, over a period of less than 2 years, so we cannot report end-results. The experience of other surgeons is much more extensive; their results are decidedly favorable.

## POSTOPERATIVE TREATMENT

Postoperative treatment remains essentially the same as that described for open reduction. The extremity is suspended with 5 pounds of traction; exercises are started in a few days after operation, for the foot, knee, and hip. At the end of 4 weeks the patient is allowed up; crutches are used for a period of 4 to 6 months, with partial weight bearing at first. A bivalved spica is used for walking for the first 4 to 8 weeks in order to maintain abduction. If the relationship of the fragments remains satisfactory at the end of 6 months, full weight bearing may be allowed. In cases of old nonunion, crutches are used for a longer period, sometimes for as much as a year. The nail is never removed in less time than a year; it may be left in for years without doing harm.

## SUMMARY

The success of any method for internal fixation of fractures of the femoral neck depends upon contributions from many sources. A satisfactory reduction can be accomplished by a simple maneuver; this was brought out and emphasized by Leadbetter. That the position is satisfactory can be verified only by taking lateral as well as anteroposterior roentgenograms; the importance of the lateral roentgenogram was first demonstrated by Leonard and George. Fractures of the femoral neck, impacted in valgus, will result in union and good function almost regardless of treatment. We feel that the principle of gentle impaction, as well as the valgus position, are important; Cotton was the first to make use of it in his impaction method; with the aid of the lateral roentgenogram his percentage of successful cases will unquestionably be higher. The mechanical principle of the means of internal fixation must be sound; the three-flanged nail has stood the test of time.

Five years have elapsed since the first report on internal fixation of fractures of the neck of the femur by means of the flanged nail was published. The principle of the nail has been widely accepted, not so the open reduction. In view of the good results reported from the use of the closed reduction, followed by nailing through a small incision, we have come to the conclusion that the open reduction is unnecessary in fresh fractures; in old ununited fractures open reduction is indicated and good results are obtained in selected cases.

No paper on fractures of the femoral neck would be complete without referring to Dr. Royal Whitman's outstanding work. He was the first to prove that these fractures could unite by bony union and thereby he stimulated efforts to achieve better results.

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## Discussion

DR. J. R. MOORE, Philadelphia: It is, indeed, a privilege and an honor to have the opportunity of discussing this excellent presentation.

The principle of internal fixation in the treatment of fresh femoral neck fractures has greatly simplified one of the most difficult fracture problems. To be able to offer to the aged patient the hope of his return to a pleasant and useful existence without the extreme physical and mental sacrifice so frequently associated with past methods is enough in itself to justify its preservation. The passing of stiff joints following prolonged fixation together with apparatus adjustment; the reduction of the period of decubitus; the decrease in lung, heart, and renal problems; and in addition, a decidedly higher instance of union and earlier restoration of function —all leave one most thankful to the author for his contribution.

The open or closed method is entirely a matter for the operator to decide. The fundamental principles of fracture treatment are still as essential and vital as ever. Bone to bone contact and accurate fixation can in no way be ignored by the introduction of a metal nail. Reduction must be obtained first. This is determined by two roentgenograms, both being absolutely essential. In the anteroposterior view one determines the proper restoration of the shaft and neck relationship, eliminating coxa vara and the associated shortening. In the lateral view of the neck, the fragments are lined up, thus eliminating the usual external rotation deformity, the accompanying angulation at the site of the fracture, and the anterior or posterior displacement of the distal fragment of the neck.

The relationship as observed in the anteroposterior roentgenogram is the easiest to obtain, and because of this fact the operator is frequently inclined to ignore or omit the lateral view. The omission of this important step is probably the most common cause of failure in reduction and non-union, whether the internal fixation by nail is employed or whether one uses any other method of reduction. I recall a case of a young woman, 22 years of age, who had what appeared to be an anatomical reduction as shown in the anteroposterior view. After 6 months' fixation in a double hip spica cast extending from the toes to the nipple line, non-union was present. The lateral roentgenogram, which had been supplanted in the beginning by the stereo-anteroposterior roentgenogram, clearly demonstrated that only slight bone contact existed. The lateral view of the femoral neck is just as important as the lateral view in a Colles's fracture.

In a series of 25 cases at the Temple University and Philadelphia General Hospitals, the so-called "blind nailing" was employed routinely in all fresh fractures in which an accurate reduction could be demonstrated in the lateral and the anteroposterior views. In those cases which could not be reduced, the open method was employed. In fractures that were 2 weeks old or older, the open method was considered imperative to insure good bone contact. The Whitman and the Leadbetter maneuvers were used uniformly to obtain reduction in the closed cases.

The period of fixation is just as important in the healing of fractures as is any other phase of the treatment. The mere introduction of the nail does not mean that bone repair is going to be accelerated. Early walking in these cases in 2, 3, or 4 weeks after reduction may be sensational, but will take its toll from the percentage of successful unions. In the above group of 25 cases, it is entirely too early to quote end results. Six known failures, however, can be attributed to either faulty reduction or permitting the patient to bear weight under the tenth week. I believe that weight bearing should be prohibited for at least 3 months, and then partial weight bearing with the aid of crutches should be insisted upon for the next 3 months. The final test of union seems to rest chiefly with the roentgenogram. One cannot be certain of union unless the fracture line is obliterated and the trabeculation pattern is restored.

Dr. Smith-Petersen has offered us a method of internal fixation for treatment of fractures of the neck of the femur. If we adhere to the fundamental principles of fracture reduction and healing, we may expect a marked improvement in our handling of this very difficult fracture problem.

DR. DEFOREST P. WILLARD, Philadelphia: Seven years ago I first had the opportunity of seeing Dr. Smith-Petersen use the flanged nail for fixation of fracture of the femoral neck. Since that time I have followed the publications on this method and its various modifications, have seen it used by other skilled surgeons, and have used it on suitable cases in our own clinics. I am convinced that the evidence that is now before us has established the fact that this form of treatment has been thoroughly tested, and that it must be given a high place among the accepted methods of treatment of this type of fracture.

It is logical that this should be so, for the procedure fully conforms to the three great fundamentals of correct treatment of any fracture—first, that

anatomical replacement of the fragments must be functionally exact; second, that this replacement must be rigidly maintained until healing takes place; third, that active motion of the adjacent joints and muscles must be started within a few days after replacement. It is obvious that there is no place in the human body where it is more difficult to carry out these axioms than in fracture of the femoral neck, and as far as my own experience goes, there is no method of nonoperative replacement and fixation that can efficiently carry out these three requirements. Any method of open operation that allows full visualization of the fractured area will, of course, allow accurate apposition of the fragments, and I am entirely convinced that lack of care in this first essential is the reason for many of our poor results. It is well known that the blood supply of the femoral head and neck, especially in adults, is extremely poor. It has also been demonstrated that the large proportion of this supply comes through the posterior part of the neck and capsule. For this reason alone open reduction with accurate alinement of the fragments gives us the best basis for the restoration of the blood supply and for ultimate recovery.

I am, therefore, not yet a convert to Dr. Smith-Petersen's latest adaptation of his method as he has described it tonight. I am still of the opinion that better results are to be obtained by full visualization of the fractured area. Certainly is this true in the cases of nonunion with which we have to deal in our clinics. It is practically impossible by any manipulative method, no matter how accurately checked by roentgenogram, to make sure that the two fragments are accurately apposed, especially as to their posterior surfaces. It is also impossible to be assured of placing raw bone in contact with raw bone in these old cases unless the fracture site is widely exposed.

The type of incision used for this open reduction is, I believe, immaterial. Any incision, or set of incisions, is efficient that will give full exposure of the fractured area and access to the external surface of the upper femoral shaft so that the nail may be easily and accurately driven. The subperiosteal flap, as first described by Dr. Smith-Petersen, or double straight incisions exposing separately the fracture site and external femoral shaft, fulfill the requirements. In many cases the double incision seems to be preferable. Local, instead of general, anesthesia may be used and much of the anesthetic shock may be eliminated. Either of these types of incision shorten the length of operation and eliminate the necessity of special roentgen-ray apparatus in the operating room.

By use of the flanged nail, the second, and third tenets of the fracture credo—rigid fixation and early motion—are, to my mind, more efficiently fulfilled than by any other method. The nail maintains the fragments in apposition, it prevents rotation, and by its rigidity it allows motion of the hip joint by voluntary muscular action earlier than other methods. This firmness of fixation has been very well shown in one of our patients in whom age and pre-existing paralysis have prevented any callus formation whatever. This patient has now been able to stand and walk for a period of over 2 years with the nail as the only support between the head and the neck of the femur.

Theoretically the criticism may be raised that the use of a foreign body, such as a nail or a pin, will cause absorption of bone and impede callus formation, but our experience is in accord with Dr. Smith-Petersen's belief that absorption in these cases has not been great enough to embarrass the healing processes.

Too much stress cannot be placed on the necessity of early active motion in this type of case. Our own experience which has been, as I have said, almost entirely with ununited fractures, convinced me that this early movement of joints and muscles plays a vital part in the restoration of blood supply in the formation of callus, and in the prevention of limitation of motion in the joints of the injured leg. It has been our custom in our postoperative treatment to use some type of balanced splint in which the leg can swing easily and to begin motion as soon as the skin wounds are healed. Plaster-of-Paris fixation is now used only in cases in which the proximal fragment is so small or so soft that there is danger of the nail tearing out.

Time does not permit of the discussion of what type of case is most suitable for this procedure or of the best moment in the posttraumatic period for the use of surgery of any sort. It is obvious that any surgical method will fall into disrepute if the proper selection of cases is not made. It is equally obvious that each case must be carefully studied, not as a simple mechanical injury to a bone, but as a living organism whose vital functions may be seriously interfered with by the best of surgery if such surgery is applied at the wrong moment. If these factors are borne in mind, I feel assured that the methods that you have heard described tonight will for many years hold their place among the most efficient procedures for conquering this difficult surgical problem.

Dr. Smith-Petersen is to be congratulated on two points: First, because he has presented to the profession an operation that has been well thought out and thoroughly proved; second, because he has stimulated our profession into new thinking about a condition in which the results have been far from satisfactory.

# THE COMBINED SPLEEN CLINIC

## Results with Medical and Surgical Therapy in Splenopathies

ALLEN O. WHIPPLE, M.D., F.A.C.S., New York, New York

DURING the past 10 years a concerted effort has been made at the College of Physicians and Surgeons to study and to teach system diseases, in which more than one therapy is applied, by a group made up of representatives of several departments. The spleen clinic is one of several such combined clinics working in the Vanderbilt clinic and the Presbyterian hospital. The patients referred to these clinics are studied by members of the medical, surgical, roentgenological, and pathological departments. Therapy is agreed upon and, whether medical, surgical, or radiological, the results are studied and evaluated from the follow-up by this same group. The workers in these clinics, from whatever department they may be, speak the same language, see eye to eye, and there are no therapeutic miracles among friends. Here, as in no other clinic, pride and prejudice disappear and an honest integration of opinions and convictions results.

Before the organization of our combined spleen and hematology clinic in 1930 we saw relatively few of these disorders. Since this clinic was started, the number of patients seen has increased some 400 per cent and the character of the records and the accuracy of the blood work in the cases studied have immeasurably improved. At present three physicians, three surgeons of the attending staff, and three of the surgical fellows work in this clinic, and three trained full time laboratory workers in hematology do the blood studies under the supervision of the attending staff. Patients with splenomegaly and allied blood dyscrasias are studied and then referred to this clinic from the various departments of the Vanderbilt clinic for consultation. After the therapy is decided upon and carried out, the patients are referred back to the combined clinic and are followed by the group in that clinic.

The advantage of having carefully trained hematologists do the blood work on these patients cannot be overemphasized. Accurate and consistent counts in platelets, reticulocytes, spherical microcytes, and the various lymphocytic and red cell differentials as well as the fragility determinations are absolutely necessary in the differential diagnosis and follow-up studies of these disorders of the hematopoetic system, and they cannot be done by a changing interne staff or by the ordinary laboratory assistant. So expert have these workers become that their services are sought in all parts of the hospital by other members of the hospital staff when accurate blood studies are needed, and the internes are now regularly asking their opinion in routine blood work.

From the standpoint of the care of the patient, teaching, and research—the three cardinal criteria of any worth while clinic—these combined clinics have every advantage. Certainly the patients get a more careful study and discriminating opinion as to proper therapy, because it is the result of agreement among medical and surgical workers based upon common follow-up studies. Overconservatism or radicalism in therapy cannot dominate such a clinic.

From the point of view of teaching one has but to ask our best undergraduate and graduate students to get a convincing statement that no other place affords such rare opportunity to study "middle ground" disease in all its phases. In view of the fact that within the next 5 years great advances will be made in graduate teaching in all our large metropolitan centers, as a result of the establishment of qualifying boards in general medicine and surgery and the medical specialties, this type of combined clinic will be in the greatest

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demand for graduate study. These clinics can and should be organized, not only in the university clinics, but in our larger municipal hospitals as well.

Because this type of clinic attracts the ablest of our graduate students and stimulates inquiry, it is here that research, both clinical and laboratory, naturally develops. A very noteworthy example of the research activities of such a combined clinic is seen in the chemical studies reported in thyroid disease from the Mayo clinic.

In our spleen clinic it was the unclassifiable splenomegalies which stimulated our interest in the investigation of portal bed obstruction and portal bed irritation, which, in turn, led three of us to make repeated visits to Puerto Rico for the study of schistosomiasis.

In the spleen clinic the splenopathies with a specific blood picture, such as the leucemias, the polycythemias, and the primary anemias, are studied and treated by a group of physicians interested in these diseases, under the direction of McAlpin and West; but there are many patients with splenomegaly that present borderline blood pictures, and these, together with the splenopathies receiving surgical therapy, are of common interest to both physician and surgeon. The diagnosis, therapy, and follow-up of these patients are shared by the combined clinic. The results of therapy in three large groups—the splenomegalies with portal obstruction, the purpura hemorrhagica group, and the splenomegalies with hemolytic jaundice—will be discussed here, inasmuch as they represent the most interesting problems of diagnosis and prognosis.

TABLE I.—CASES SEEN IN THE COMBINED SPLEEN CLINIC

| Classification | Cases | Splenectomy | Died |
|---|---|---|---|
| Banti's syndrome | 54 | 41 | 4 |
| Schistosomiasis | 14 | 6 | 2 |
| Unclassified splenomegaly | 19 | 5 | 0 |
| Typical hemolytic jaundice | 40 | 18 | 0 |
| Atypical hemolytic jaundice | 12 | 5 | 1 |
| Gaucher's disease | 4 | 4 | 1 |
| Syphilis of spleen | 4 | 0 | 0 |
| Cooley's syndrome | 4 | 2 | 0 |
| Splenomegaly with chronic colitis | 2 | 0 | 0 |
| Sarcoma of spleen | 1 | 1 | 0 |
| Purpura hemorrhagica | 43 | 19 | 2 |
| Polycythemia | 45 | 1 | 0 |
| Acute leucemia | 67 | 0 | 0 |
| Chronic lymphatic leucemia | 68 | 0 | 0 |
| Chronic myeloid leucemia | 85 | 0 | 0 |
| Osteosclerotic anemia | 1 | 1 | 0 |
| Hypochromic anemia | 1 | 0 | 0 |
| Hodgkin's disease | 132 | 1 | 0 |
| Sickle cell anemia | 5 | 2 | 0 |
| | 601 | 106 | 10 |

## SPLENOMEGALY ASSOCIATED WITH PORTAL OBSTRUCTION AND HYPERTENSION

As the patients with splenomegaly associated with anemia and manifestations of portal obstruction came to us in the spleen clinic and were studied more carefully, we became more and more convinced that Banti's disease was not a distinct clinical entity, and that a heterogeneous group of cases existed in the clinic presenting certain similar characteristics. For want of a better term we grouped these cases under the name of "Banti's syndrome." We have sought a common etiological factor operating in these different cases of splenomegaly to produce a similar clinical syndrome. The following criteria, as originally laid down by Banti, were used to determine the eligibility of each particular case for classification within the syndrome of Banti. In each individual there were splenomegaly, a secondary anemia of varying severity, a leucopenia, and evidences of portal obstruction as seen by hemorrhages or ascites. From a total number of 68 cases we have chosen 31, because they have been very carefully studied and recorded, for a report in this group.

In all these cases splenectomy was performed. These patients all received detailed clinical and hematological studies before operation and were similarly studied for long periods after operation. The 31 cases include an age group from early childhood to adult life. There were 16 females and 15 males.

*Symptomatology.* The common symptom of asthenia and lassitude, so often seen with anemia, and the presence of an enlarged spleen are not considered serious enough in the majority of cases to bring the patient in for surgical opinion. By far the largest number of patients in this group, 16 in fact, declared that they had noted gradually developing weakness for a period of years. Next in frequency, and often distressing, was the gradual enlargement of the abdomen, usually due to the

enlargement of the spleen. The most alarming symptom to the patient, the determining symptom, was hematemesis. In 11 cases the individual was unaware of the disease until the sudden appearance of bloody vomitus. Pain was present in 50 per cent of the cases, but it varied in degree and location.

*Examination.* An enlarged spleen, secondary anemia, and leucopenia were noted in all these cases. Thrombocytopenia was present in 40 per cent, but we disagree with Rosenthal's subdivision of Banti's disease into the thrombocythemic and thrombocytopenic.

*Pathology.* The spleen showed a thickened capsule with increased resistance on gross section. There was usually a marked replacement of normal spleen tissue by fibrous tissue with dilatation of the veins. Fibrosis is the most striking feature in the gross and microscopic examination of these spleens. In many patients the liver showed various grades of cirrhosis, as shown by biopsy.

In the portal bed, there is uniformly a splenic venous engorgement which frequently extends into the portal system, giving rise to a rich collateral circulation in the adhesions surrounding the spleen. The veins in the splenic pedicle in some of these cases often reach a diameter of two to five times their normal caliber. We have very definite evidence that in this group of cases there is a marked portal hypertension with and without gross evidence of an obstructive factor. Dr. John Caughey, of our medical staff, has recently been making interesting studies on the venous pressure in the splenic vein at the time of splenectomy in the various types of splenomegaly seen at the operating table. These studies, which will be reported later, have interested us exceedingly; for in many of these cases of Banti's syndrome the venous pressure in the splenic vein has been three and four times that recorded simultaneously in the peripheral venous system.

*The obstructive factor.* Both the German school of pathology and the English school of physiology have produced evidence that portal stenosis may result in splenomegaly, and have evidences showing that the factors of increased portal pressure as well as the entry of toxic substances in the portal circulation may cause a splenomegaly.

In our series we had 15 cases in which either at the time of operation or subsequently, no obstructive mechanism could be demonstrated. These 15 cases showed no evidence of cirrhosis, and because of the limited exposure at operation a detailed examination of the portal bed was impossible. But this group presents a rather wide gap in our evidence to support the theory of venous obstruction as to the causative agent. The 16 remaining cases include 9 cases of Laënnec's cirrhosis, 2 cases of unclassified cirrhosis, 2 cases of schistosomiasis, 2 cases of thrombosis of the splenic vein, and 1 case of cavernomatous transformation of the portal vein.

*Response to splenectomy.* All the cases recorded in the foregoing sections have been followed carefully, and the response to splenectomy will be considered according to groups. The follow-up results in the various groups can be traced in Table II. The cases are retained in the groupings as previously described: (1) Laënnec's cirrhosis, (2) unclassified cirrhosis, (3) Schistosomiasis mansoni, (4) thrombosis of the splenic vein, (5) cavernomatous transformation of the portal vein, (6) obstructive factor not demonstrated.

It is immediately apparent that the poorest results appear in the group having Laënnec cirrhosis. There were 9 cases presenting the combination of this type of cirrhosis and Banti's syndrome. The immediate hospital mortality included 2 cases, or 22 per cent. One of these patients died of hematemesis and 1 of surgical shock. The 5 remaining fatalities occurred in periods varying from 3 months to 13 years. Four patients succumbed to severe hematemesis and the fifth had recurring ascites and died of hepatic insufficiency. In spite of the poor late results, 66 per cent of the group were well from periods varying from 2 to 13 years after the operation was performed.

The outcome of the succeeding groups was obviously much more encouraging. The patients having the unclassified type of cirrhosis, Schistosomiasis mansoni, or thrombosis of the splenic vein, have all done exceedingly well. As seen in Table II, these individuals have been entirely symptom free and have remained well for long periods.

The 1 patient with cavernomatous transformation of the portal vein had had repeated hematemeses for 2 years prior to operation and promptly succumbed to a similar massive hemorrhage 48 hours after operation.

Our last series of 15 cases in which the "obstructive factor" could not be demonstrated gave a hospital mortality of 2 cases, or 13 per cent, and a late mortality of 3 cases, or 20 per cent. The 10 remaining patients (66⅔ per cent) have, with 1 exception, continued in excellent health for periods up to 10 years. (Since the completion of this paper we have again seen Case 9 in group 6. It has now been 16 years since the splenectomy. The patient is in excellent health; physical examination is negative and all blood values, including the platelet count, are normal.) The single exception has had a miserable clinical course punctuated by repeated hematemeses over a span of 10 years and is still alive. The cause of death in the last series included 1 case each of hematemesis, hepatic insufficiency, brain cyst, cerebral thrombosis, and surgical shock.

From the foregoing experience one is immediately impressed with the gravity of hematemesis as a prognostic sign. Of the 11 patients who had evidence of esophageal hemorrhage prior to operation, 7 died of the same complication. We have accordingly accepted hematemesis as an ominous symptom and feel that in this type of case operation should be avoided.

Although thrombotic phenomena are reported as being frequent sequelæ of splenectomy in Banti's syndrome, only 1 patient in this study had this complication. Rosenthal has emphasized the danger of thrombosis after splenectomy in the "thrombocythemic" form of Banti's disease. Our experience does not confirm this observation.

TABLE II.—END-RESULTS

| Group | Case | Years followed | Result |
|---|---|---|---|
| Laënnec's cirrhosis—9 cases | 1 | 3½ | Excellent |
| | 2 | 13 | Well 13 years, then hematemesis, death |
| | 3 | 6 | Recurring ascites, death |
| | 4 | 5 | Excellent, no ascites |
| | 5 | 0 | Hematemesis, death, 12th day |
| | 6 | 0 | Postoperative shock, death 6 hrs. |
| | 7 | 3 mos. | Hematemesis, death, 3 months |
| | 8 | 2 | Well 2 years, then hematemesis, death |
| | 9 | 4¾ | Well 4¾ yrs., then hematemesis, death |
| Unclassified—2 cases | 1 | 11 | Excellent |
| | 2 | 2 | Excellent |
| Schistosomiasis mansoni—2 cases | 1 | 2 | Excellent |
| | 2 | 2 | Excellent |
| Thrombosis of splenic vein 2 cases | 1 | 3½ | Excellent |
| | 2 | 3 | Excellent |
| Cavernomatous transformation of portal vein—1 case | 1 | 0 | Hematemesis, death, 2 days |
| Obstructive factor not demonstrated—15 cases | 1 | 4 | Excellent |
| | 2 | 10 | Well 2 yrs., repeated hematemesis, 8 yrs. |
| | 3 | 2 | Well 1½ yrs., then repeated hematemesis and death |
| | 4 | 4 | Excellent |
| | 5 | 1 | Died of cyst of pancreas |
| | 6 | 8 | Excellent |
| | 7 | 1 | Well 1 yr., cerebral thrombosis, death |
| | 8 | 6 | Excellent |
| | 9 | 10 | Excellent |
| | 10 | 1 mo. | Recurring ascites, death 1 mo. |
| | 11 | 7 | Excellent |
| | 12 | 0 | Postoperative shock, death 16 hrs. |
| | 13 | 5 | Excellent |
| | 14 | 9 | Excellent |
| | 15 | 10 | Excellent |

### THROMBOCYTOPENIC PURPURA HEMORRHAGICA

In 1735 the great clinician Werlhoff established this disease as a clear cut entity, but little was added to the knowledge of the disease until 1887 when the Belgian histologist, Denys, made the most noteworthy contribution in describing the absence of platelets in blood smears in cases of purpura. In 1891 Hayem made the original observation of slow or absent clot retractility in this disease. In 1910 Duke described his method for determining the bleeding time and reported 2 cases of purpura with prolonged bleeding time. In 1916 Schloffer, of Prague, at Kaznelson's suggestion performed the first splenectomy in the treatment of the condition and this case, reported by Kaznelson, created a new interest in the disease.

Since 1916 a number of reports on collected splenectomies for this disease have been reported—those of Whipple in 1926, Spence in 1928, Eliason in 1932, Giffin in the same year, and Pemberton in 1934. The largest series from any one clinic was that from the Mayo clinic, 57 cases being reported by Pemberton in 1934. The operative mortality of 7 per cent

TABLE III

| | Operated upon group | Not operated upon | Totals |
|---|---|---|---|
| Completely arrested | 5 | 3 | 8 |
| Markedly improved | 4 | 0 | 4 |
| Improved | 1 | 2 | 3 |
| Unimproved | 0 | 5 | 5 |
| Died | 1 | 1 | 2 |
| Total | 11 | 11 | 22 |

is as good as any hitherto reported. Permanent remission of the disease was noted in 63 per cent of this series, an additional 35 per cent were improved, and in only 1 case did the disease recur in acute form.

The majority of the reports indicated a much higher mortality if splenectomy was done in the acute stage of the purpura. More recently, however, with more accurate diagnosis, better pre-operative preparation of the patient, and improvements in anesthesia and surgical technique, a much lower operative mortality is noted. Thus at present available figures indicate an operative mortality of 7 per cent for all cases of thrombocytopenic purpura; 14 per cent for the acute cases and 5 to 6 per cent for the chronic or non-fulminating cases.

In this report we wish to present 3 groups of cases, 22 typical cases and 8 atypical. The first group of 22 cases includes all cases adequately studied and sufficiently followed to establish the diagnosis beyond reasonable doubt. Eleven of these have been splenectomized and followed for an average interval of 5½ years, the longest follow-up being 11 years, the shortest, 11 months. A corresponding number of patients treated medically are reported as a control group. They have been followed for an average period of 4 years, the longest follow-up being 11 years and the shortest, 1 month.

In selecting this parallel series we have rigidly adhered to certain criteria in the diagnosis of idiopathic or essential thrombocytopenic purpura. In no instance was an obvious causative factor involved, such as an associated infection, and as regards the blood studies, they were done by our expert hematologists. No patient showed a platelet count above 45,000; the bleeding times were prolonged, and the clotting times normal; the clot retraction was delayed in all but 2 cases of the 16 in which it was recorded; the tourniquet test was negative in only 1 case in which it was applied. The anemia, when present, was always of the secondary type; no white cell counts below 5,300 were recorded, and the differential counts were within normal limits. Thus we feel that these 22 cases conform to the rigid requirements in the diagnosis.

TABLE IV.—ATYPICAL PURPURA CASES WITH SPLENECTOMY

| | Cases |
|---|---|
| Completely arrested (follow-up of 7, 7, and 3 years) | 3 |
| Markedly improved | 0 |
| Unimproved (follow-up of 3 years) | 1 |
| Died | 4 |

Table III shows the results of medical and surgical therapy in these parallel series. There was no operative death in the splenectomy cases. The death recorded occurred 18 months after operation following a restoration of health for 16 months. Death followed a fulminating recurrence of the disease with cerebral hemorrhage as the cause of death.

### ATYPICAL PURPURA HEMORRHAGICA

The group of 8 atypical cases is here reported because these cases did not conform to our rigid standards in the diagnosis of idiopathic thrombocytopenic purpura, but the patients all had had a severe bleeding tendency unrelieved by medical measures and all came to splenectomy. These cases did not show as good results as the typical cases, and yet splenectomy was used as a last therapeutic resort. As a group they will be reported in detail by Elliott and Brown of our combined clinic.

In all these cases the spleen was removed. A thrombocytopenia was present in 7 cases; the platelets were normal in 1 case.

Satisfactory results followed splenectomy in only 3 instances; in 1 case the bleeding tendency does not seem to have been affected by operation. The 4 remaining patients are dead: 1 of the patients died before leaving the operating table, 1 succumbed to a postoperative complication, and the 2 remaining died within less than a year after splenectomy of diseases to which the purpura was apparently secondary.

In 1 of the 3 cases which have been benefited by operation, the bleeding tendency has been completely arrested for 7 years. In another it has been markedly diminished for the same period of time. And in the third a slight but definite improvement has been maintained during the 3 years that the patient has been followed. Were it not for the rigidity of our classification, the first 2 of these cases would be placed in the "idiopathic group." It is therefore not surprising that they were benefited by splenectomy. The third case, one of mild purpura without thrombocytopenia, might never have come to splenectomy had not the need for other operative procedures made it seem advisable to attempt to alter the bleeding tendency.

While it is impossible to make any statistical deductions from a series of this size, we feel that these cases clearly illustrate the diagnostic pitfall, the often futile operations, and the high mortality so frequently encountered among the atypical purpuras.

### HEMOLYTIC JAUNDICE—TYPICAL AND ATYPICAL FORMS: A REVIEW OF 46 CASES

I am indebted to Dr. Thompson of our spleen clinic for the following summary:

The term hemolytic jaundice has been used as a general diagnosis to include all patients presenting increased hemolysis of red cells within the body coincident with evidence of regeneration. In practice this definition is associated with variable jaundice and splenomegaly.

The spleen clinic, after many attempts to classify further the diseases causing this syndrome, has finally thought it wise to accept only two subdivisions. The first of these is a uniform, recognizable, curable entity: typical hemolytic jaundice. The second subdivision consists of a heterogeneous variety of disturbances grouped together under the intentionally vague term: the atypical hemolytic anemias.

*Typical hemolytic jaundice.* Typical hemolytic jaundice is, in our experience, a very uniform and readily recognizable disease entity, provided certain diagnostic criteria are rigidly maintained. It is a chronic disease of long duration and of relative mildness. Acute exacerbations may occur, but these acute episodes are not common. The present symptom is chronic, variable jaundice, and the outstanding physical finding is splenomegaly. A positive diagnosis is made in the laboratory. In all cases of typical hemolytic jaundice, the peripheral blood contains the spherical microcytes that we believe are as pathognomonic of this disease as are the sickle cells in sickle cell anemia.

TABLE V.—SPLEEN CLINIC FIGURES ON HEMOLYTIC JAUNDICE

| | Cases |
|---|---|
| Total | 46 |
| Total typical hemolytic jaundice | 31 |
| With splenectomy | 17 |
| Without splenectomy | 14 |
| Analysis of 17 splenectomized— | |
| Died third day after operation | 1 |
| Died later of poliomyelitis, hemolytic jaundice cured | 1 |
| Died later of carcinoma, hemolytic jaundice cured | 1 |
| Died later of sarcoma, hemolytic jaundice cured | 1 |
| Alive, free of symptoms—no anemia, no jaundice, up to 16 years following operation | 13 |
| Analysis of 14 not splenectomized— | |
| All continued to have moderate variable jaundice and anemia | 14 |
| Total atypical hemolytic anemia | 15 |
| Tumors present | 4 |
| Syphilis | 2 |
| Tuberculosis | 1 |
| Unknown disease | 8 |
| Splenectomy was done in | 4 |
| Died shortly after operation of hemolytic process | 2 |
| Unimproved | 2 |

We in the spleen clinic have had the opportunity of studying 31 cases of this typical disease; of these, 17 patients have had the spleen removed. The more important clinical and laboratory data regarding this group are presented in Table V.

*The atypical hemolytic anemias.* In marked contrast to typical hemolytic jaundice is our experience with the atypical hemolytic anemias. In the former group a definite diagnosis is promptly available, knowledge of the disease mechanism is accumulating, and the results of splenectomy can be predicted with security.

The atypical group comprises a total of 15 cases presenting subacute or chronic acholuric jaundice, anemia with evidence of regeneration, and splenomegaly. In all 15 the possibility of typical hemolytic jaundice was considered, and in all 15 this diagnosis could not be sustained because the blood failed to

reveal the spherical microcytes with their attendant fragility changes.

In summary form, our clinical experience with this group of 46 cases was led to the following tenets:

1. The syndrome of chronic variable acholuric jaundice, chronic variable anemia with regeneration, and moderate to marked splenic enlargement indicates the presence of a hemolytic process within the body.

2. Cases presenting this syndrome may be divided into two major groups: (a) typical hemolytic jaundice; (b) the atypical hemolytic anemias.

3. The first symptoms of either group may have their onset at any age and in any race. There is no appreciable sex difference in the incidence.

4. Although the familial background of a similar process is somewhat more common in the typical hemolytic jaundice group, this family history may be present or absent in either group without affecting the diagnosis in any way. The former subdivision of cases into congenital and acquired types is therefore no longer valid.

5. Typical hemolytic jaundice is a clear cut definite disease entity, the diagnosis of which depends upon the finding of spherical microcytes, with their attendant fragility changes, in the peripheral blood. Once the active phase of this disease is established, it will continue, with fluctuations in intensity, until splenectomy is performed. The splenic pathology is uniform and characteristic. Splenectomy results in an immediate cessation of the increased hemolytic activity with a prompt return of the blood values to normal. These brilliant results have been observed in all cases and persist without exception for as long a period as 16 years following splenectomy.

6. The atypical hemolytic anemias comprise a heterogeneous group of disturbances that are associated with increased blood destruction and splenic enlargement. In some of our cases the primary disturbance has been neoplastic, in others infectious, in many unknown. Splenectomy is not indicated, for obvious reasons, in this group.

7. Correct clinical ante-operative diagnosis is therefore essential.

## Discussion

DR. ELDRIDGE L. ELIASON, Philadelphia: Dr. Whipple should be complimented upon his most interesting and instructive presentation. The combined clinic idea certainly seems to have been beneficial and at the same time has added refinement of diagnosis. It surely minimizes the mistakes that may arise in the laboratory data which occur all too frequently due to changing personnel. The speaker has clearly shown that the close attention of the clinic staff to these details has resulted in a clarification between what is described as the typical in contrast to the atypical types of splenopathy. This information determines those cases that surgery will help as against those in which medical treatment is indicated. As Dr. Whipple has stated, prejudice must give way to integration of opinions. Under this regimen the mortality rate should be lowered.

Surgery of the spleen has been practiced since before Christ. Literature has it that the Greeks performed splenectomy upon their runners, with the belief that their speed and possibly endurance were thereby increased. Spencer Wells in 1865 did the first splenectomy of modern times. Splenectomy is not a difficult operation in the absence of adhesions. In fact, although spectacular, it is relatively simple. Therefore the dangers aside from a careless injury to pancreas or stomach arise chiefly from the patient's condition. Ofttimes these patients have been sick for years with anemia, ascites, cirrhosis, and blood dyscrasias. Better preparation, more accurate determination of the pathological conditions, and the accepted time for operation have added much to the patient's chances. In purpura, for example, the former high mortality rate was due to surgical shock. The use of transfusion made the operation even in acute cases safer than it formerly was in chronic cases.

I am sure we all have attempted to practice the combined clinic idea mentioned by having numerous consultations, but the combined clinic uses these aids to the best advantage. Dr. Whipple has called attention to the fact that splenectomy shows its highest mortality in Banti's syndrome and further, that the mortality occurs in the advanced cases with demonstrable cirrhosis and ascites. In our series of 53 splenectomies from Surgical Services B (Dr. George P. Muller) and C (Dr. E. L. Eliason) of the hospital of the University of Pennsylvania, 21 were done for Banti's disease. Eight of the 10 deaths of the entire series were in this class and occurred in patients with cirrhosis or jaundice. We no longer operate upon these hopeless cases except for relief of

discomfort. In the past Talma operations were sometimes attempted. We had no deaths in 12 cases of typical hemolytic jaundice. The 7 cases of purpura hemorrhagica have all lived. Ruptured spleen cases all survived. One patient with aplastic anemia and 1 with subacute bacterial endocarditis with splenomegaly died. Our series was grouped under 10 diagnoses as compared with the 19 in the combined clinic report. Unfortunately, not having a combined clinic, we are not able to present those splenopathies under medical regimen.

A word about the surgical procedure may be apropos, points learned from watching some master surgeons. Standing on the patient's right, we found a left upper paramedian rectus incision the best, made into a hockey stick type if needed. If the spleen be massive, it is best, after packing the viscera away, to free the posterior inferior peritoneal attachments first, simply as Bevan has described by insinuating the tips of the gloved fingers of the right hand along the gutter formed by the peritoneal reflection. The lower pole of the spleen is then delivered out of the wound and a gauze pack placed in the vacated space. This will act as a skid aiding the perfection of delivery as the fingers continue to separate the peritoneal attachment, thus permitting the complete delivery of the organ mesially. A large pack is immediately placed in the vacated bed. The organ is then adducted or rolled toward the midline; the tail of the pancreas is easily seen and separated from the pedicle now bared of its posterior peritoneal coat. The spleen is next lifted off the abdomen, thus exposing the anterior surfaces of the pedicle. The peritoneum over this is slit and the vessels easily and safely ligated. It should be borne in mind that the splenic artery frequently runs parallel to the long axis of the spleen, sending its branches into the organ during its course—an important element to recognize. After closure a large pad is fastened on the abdomen with a binder and pitressin is given to prevent distention. Should gall stones be encountered in the hemolytic jaundice cases they are not attacked. After splenectomy the patient frequently has slight fever for 8 to 10 days. Following these principles there have been but 2 deaths in the last 35 of the 53 cases in this series.

Dr. Edward B. Krumbhaar, Philadelphia (abstract): Banti's syndrome should not include splenic anemias of known etiology; in the present series the nature of half of these cases remains in interesting obscurity. In regard to the third group, jaundice due to increased hemolysis may occur in many conditions. "Chronic Hemolytic Jaundice with Splenomegaly," however, is a well recognized and preferable term for the condition here described as "Typical Hemolytic Jaundice." "Atypical Hemolytic Anemia" is also an undesirable term because it includes many often recognizable unrelated conditions. Chronic cases of anemia and splenomegaly should not have spleens removed without other definite indications. One must agree that the group study of systemic diseases and the need for expert examinations in hematological research are both highly desirable.

# THE MANAGEMENT OF SEVERE HYPERTHYROIDISM

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A PAPER on any clinical subject may well first present what one thinks is the present state of the subject, then the reason why this state exists, and lastly what can be done to improve it.

We have now done 15,200 thyroid operations upon 13,000 patients. The mortality rate, counting all such patients who died from any cause whatever while in the hospital, is 0.85 per cent. This represents a total number of 111 deaths in 13,000 patients. Of this number, 40 per cent died in a thyroid crisis, 10 per cent were thyrocardiacs who died in cardiac failure, and 10 per cent died of emboli. The remainder died of carcinoma and other causes not related to the subject of this paper. The latter were patients not in a toxic state such as mediastinitis which follows the removal of intrathoracic goiters; a small number with nontoxic adenoma died with emboli; the other deaths were from pneumonia in connection with nontoxic goiter and from accidents which occasionally occur in such a large series of operations, such as tracheal collapse, typhoid fever, measles, and fracture of the skull from a fall on the hospital stairs on the way home. In the years during which these 15,200 thyroid operations were being performed, there were 53 nonoperative deaths from acute hyperthyroidism, embolism, or cardiac failure. These occurred in patients in such advanced degrees of severe hyperthyroidism associated with delirium, vomiting, and diarrhea, or in such an advanced stage of decompensation that no operative procedure could be even remotely considered. It is of interest to realize that of these patients dying in the clinic before they could be prepared for operation, 33 per cent died in a thyroid crisis, 14 per cent died of embolism, and 15 per cent died of cardiac failure. In this group all measures to combat the severe hyperthyroidism were unsuccessfully employed. It must be stated, however, that in the first half of our experience these measures were not as adequate and effectual as in the latter half, when we had a sounder conception of the pathological physiology, and of the measures necessary to neutralize these abnormal physiological processes.

On the other hand, this group of patients present striking evidence that they, or their physicians, have not appreciated that this severe thyroid state could occur and was occurring, and were in many cases unaware of the proper measures to combat it. Whether or not one subscribes to the almost universally accepted conviction that surgery in the form of subtotal thyroidectomy is the most certain means of permanently and completely relieving patients of hyperthyroidism, these nonoperative deaths stand out vividly as a warning that whoever permits patients to suffer the effects of uncontrolled hyperthyroidism over a long period of time must accept the ever present possibility of the development of such an acute state and an avoidable fatality. In defense of those physicians who have permitted patients to pass into such severe states before delivering them into the hands of surgeons qualified by training and experience to handle such cases, or perhaps never doing so, it should be pointed out that while clinics handling patients with hyperthyroidism in large numbers are constantly dealing with those serious states, family physicians may well go several years without encountering them, and so be unprepared by experience to appreciate or deal with such a situation. Figures 1–8 are examples of the severe degrees of hyperthyroidism and the severe degrees of cardiac decompensation to which these patients can progress.

To gain some knowledge of the number of deaths occurring from thyroid disease, generally, we have secured information from the Bureaus of Vital Statistics of the States of Massachusetts, New York, and Pennsylvania as to the number of thyroid deaths in these

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TABLE I.—VITAL STATISTICS AS TO THYROID DEATHS IN MASSACHUSETTS, PENNSYLVANIA, NEW YORK IN THE PAST SIX YEARS

| | Massachusetts | New York | Pennsylvania |
|---|---|---|---|
| 1930 | 75 | 492 | 413 |
| 1931 | 73 | 468 | 388 |
| 1932 | 58 | 479 | 361 |
| 1933 | 74 | 400 | 329 |
| 1934 | 55 | 401 | 342 |
| 1935 | 53 | 478 | 382 |
| Total | 388 | 2718 | 2215 |

1930–1936 Total thyroid deaths in the past six years—5321

Table I. The definitely lower number of deaths in Massachusetts during this 6 year period is not entirely explained, we believe, by the fewer number of people living in Massachusetts. It is distinctly possible that this low figure may well be related to the fact that Massachusetts physicians have been taught to care for patients with hyperthyroidism early. These figures are of importance when one realizes that in 15,300 operations on 13,000 people, spread over a period of approximately 15 years, but 111 have died. We believe that better education and earlier operations could have saved many of these 5,321 patients who have died in these 3 states.

Fig. 1, left. A severe and advanced case of hyperthyroidism before operation.

Fig. 2. The same patient as in Figure 1, after subtotal thyroidectomy. These photographs demonstrate the extreme state to which a patient with severe hyperthyroidism may progress.

states during the last 6 years. A great majority of these deaths were due to hyperthyroidism. The figures are submitted in Table I.

As the result of our own experience, we feel convinced that a great many of these patients need not die and that a discussion of why this is so might well result in a diminution of these deaths. Most of the mortality in thyroid disease is the result of permitting a patient with hyperthyroidism to progress to a state which we have termed a thyroid crisis, a state represented by those patients with the disease who have reached a severe stage of hyperthyroidism, or it is the result of permitting hyperthyroidism to exist too long in patients with grossly crippled hearts, in whom lesser degrees of thyroid intoxication bring about those serious states represented most often by emboli or cardiac failure associated with cardiac arrhythmia (auricular fibrillation). Some of the mortality shown in the quoted reports of vital statistics is undoubtedly due to surgery (less than one-third were operative deaths) which was not up to the best standard, from the point of view of time and type of operation, pre-operative and postoperative preparation, and the technical performance of the operation itself. In many of the cases, however, it is probable that the best possible judgment and excellent technical skill were employed; we have had painfully impressed upon us throughout this large experience the impossibility, at least for us, of avoiding some mortality in this serious group of cases.

While there are a few thyroid crises that develop quickly, in half a day to 48 hours, it is true that this acute intoxication usually takes several days to weeks to develop, during which time adequate warning signs of the seriousness of the situation are evident. It is also true that thyrocardiacs in whom less intense degrees of thyroid intoxication bring about most serious states, largely represented by emboli or heart failure, do not show as obvious signs of an impending serious state as do patients approaching a thyroid crisis. Nevertheless, definite danger signs are almost always present, and if they are heeded and the patient is relieved of his hyperthyroidism, emboli and failure are unlikely to occur; in addition, the patients will have been greatly improved as to general health and activity. Furthermore, even if patients are first seen when in a state of acute hyperthyroidism, a proper conception of what is causing this state to persist and progress, and the application of proper principles to combat it will extricate most of these patients from these states. The patients will be so improved that they are not only removed temporarily from the danger of an immediate fatality, but can be so prepared

Fig. 3, left. Severe hyperthyroidism before operation.

Fig. 4. Patient after operation; severe hyperthyroidism similar to that shown in Figure 1.

TABLE II.—STAGE OPERATIONS IN RELATION TO THE PRE-OPERATIVE BLOOD IODINE LEVEL

| | Elevated blood iodine | Normal blood iodine |
|---|---|---|
| No. of cases | 224 (70%) | 107 (30%) |
| Stage operations | 38 | 49 |
| Percentage of group | 17 | 45.8 |

Note here that in 70 per cent of the cases of hyperthyroidism there was an elevation of blood iodine before operation, and in 30 per cent of the cases, a normal blood iodine before operation. As an indication of the seriousness of the latter group, note that in those patients having elevated blood iodines before operation, but 17 per cent required stage operations; while in those having a normal blood iodine before operation, 45.8 per cent required stage operations. This leads us to suspect that normal blood iodines before operation are possibly an indication of a severe type of hyperthyroidism.

that subtotal thyroidectomy can be done with a very reasonable risk rate (3.5 per cent); so that not only is the danger of an immediate mortality eliminated, but the patient is completely relieved of the intoxication, and in 90 per cent of the cases is permanently restored to normal health.

Our purpose in this discussion is to indicate what we believe brings about an acute crisis in patients with severe hyperthyroidism in the conviction that this state is brought about by factors quite remote from the thyroid; to point out the danger signals indicating that such a critical state is imminent and the combative measures required, based upon our belief and the evidence submitted in its support, that the acute state is caused by, and persists because of, the secondary effects of hyperthyroidism on liver function. We shall also point out the advantages of multiple stage operative measures in dealing with such patients.

It is more or less generally admitted that hyperthyroidism is the result of the production in the thyroid, and the discharge into the blood stream, of an excessive amount of thyroxin. That this is true, with the exceptions demonstrated in the atypical blood iodine chart which occur in 30 per cent of the cases, is borne out by the blood iodine investigations conducted in our clinic by Mr. H. J. Perkin. (Table II.) Dr. R. B. Cattell in our clinic some years ago, after the work of Dr. David Marine, demonstrated that during active hyperthyroidism there is a low iodine content in the thyroid tissue removed at this time and that following improvement in any method of treatment, there is a rise in the iodine content of the thyroid tissue. Mr. Perkin has now further added to this the fact that before operation in approximately 70 per cent of the cases, there is an abnormally high blood iodine in patients with hyperthyroidism as shown in Figure 9, and that following adequate subtotal thyroidectomy in those cases there is a drop of blood iodine to normal, which quite definitely parallels the fall to normal of the pre-operation elevated basal metabolism, likewise following an adequate subtotal thyroidectomy, as shown in Figure 9. This evidence, when correlated with the fact that the active principle of the thyroid gland, thyroxin, is over 60 per cent iodine, and with the additional fact that separation of the iodine fraction in thyroxin makes it inactive as a substitute for normal thyroid secretion, at least lends additional strength to the deduction that hyperthyroidism is due to an excessive introduction of thyroxin into the blood.

It quite naturally follows, owing to the fact that we have always thought of hyperthyroidism in terms of excessive secretion mechanically controllable by surgical removal of a portion of the gland, that we have tended to visualize advanced, severe hyperthyroidism as but a further intensification of this intoxication in terms of a more excessive production of thyroid secretion.

I have for a considerable time believed that when an acute thyroid crisis eventuates, some

other factors have become involved, as indicated by the frequent and quite sudden occurrence at this time of a different group of symptoms: delirium, vomiting, diarrhea and temperature elevations reading to 105 and 106 degrees; it has seemed probable that from a clinical standpoint these reactions are the result of liver effects, as suggested by the abnormally low amounts of glycogen found in the liver in patients dying of severe hyperthyroidism and by the fact that patients in this state are often so dramatically benefited by the constant employment of measures combating lowered liver function, that is, intravenous injection of glucose and fluids. Furthermore, this serves to explain the excessive temperature reactions occuring at this time, even in patients with acute thyroid crises who had no operative procedure.

In keeping with these clinical deductions during the last part of our experience, our combative measures have been directed not only toward control of hyperthyroidism by iodine, rest, and sedatives, but also toward protection of the liver by the continuous intravenous injection of fluids and large amounts of glucose. The result is that our clinical experience has been much more gratifying; it has even been possible in many cases not only to extricate the patients from a thyroid crisis by control of their vomiting, diarrhea, and delirium, but to operate upon them after a period of preparation of 2 to 3 weeks with a very reasonable mortality rate, 3.5 per cent.

As the result of our clinical experience, investigation as to liver function before and after operation has been undertaken in the clinic by Dr. E. C. Bartels using hippuric acid determinations as an index of liver function. That these investigations have at least so far corroborated our clinical impressions is shown in Dr. Bartels' figures (Fig. 10). It will be noted in these charts that the liver function in patients with hyperthyroidism compares quite favorably with the level of metabolism, indicating the degree of clinical toxicity, and also with the surgical opinion regarding the type of operation required. It appears to be reduced on entrance to the hospital, to rise during the period of hospital rest and pre-operative management, consisting of Lugol's solution, high caloric diet, rest, and the intravenous injection of glucose and fluids. It then appears to fall as the result of the reaction following subtotal or hemithyroidectomy, and is found to have risen to normal in those patients seen 3 months after operation, with lowered metabolisms and relief of their hyperthyroidism.

Fig. 5. A patient in the most extreme state of hyperthyroidism. This patient died of embolus on the ninth day following right hemithyroidectomy.

Fig. 6, right. The bodily appearance of a patient with advanced and severe hyperthyroidism. This patient survived a 2-stage subtotal thyroidectomy, has regained her weight, and is entirely well.

With all these facts in mind, we have visualized acute thyroid crises, to put it in simple terms, as the consumption of the protective element in the liver by the excessive combustion processes, associated with the excessive production of thyroxin by the thyroid, and the effect produced upon combustion by its presence in excessive quantities in the blood stream.

While some would not agree with the statements that subtotal thyroidectomy is advisable in all patients with hyperthyroidism who show no progressive and convincingly obvious improvement after 3 to 4 weeks of nonoperative treatment, this is the definite conviction which we have reached as the result of our experience with this large group of cases. We wish particularly to respect the viewpoint of any who do not agree with our position; and with that in mind, we feel sure that few can reasonably disagree with the position that at

Fig. 7. Ascites and marked general anasarca in a patient with hyperthyroidism and cardiac decompensation.

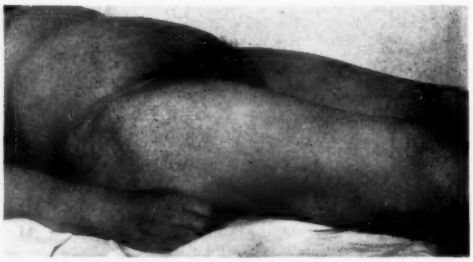

Fig. 8. Complete relief from decompensation, disappearance of ascites and general anasarca following subtotal thyroidectomy. This case demonstrates the advanced states which can occur in thyrocardiacs.

least all patients with hyperthyroidism who show no improvement, but in whom the disease is becoming intense, should immediately be submitted to subtotal thyroidectomy. We feel strongly that any patient with cardiac damage, as shown by mild failures or cardiac arhythmia should be immediately prepared for surgery and operated upon without a preliminary trial of nonoperative measures. One can thus in almost all of these cases promise relief from incipient heart failure, a striking increase in cardiac capacity as relates to sustained activity, and, by the administration of quinidine for a few days after the patient has been freed from the hyperthyroidism, a restoration of cardiac rhythm to normal in over 70 per cent of the cases.

Owing to the fact that auricular fibrillation associated with hyperthyroidism for a long period of time produces few disturbing effects upon patients with hyperthyroidism and heart failure, auricular fibrillation has been accepted all too lightly as possessing a quite non-serious aspect. As an indication that this is so, I have not infrequently heard the purely conjectural statement that patients with auricular fibrillation stand surgery even better than those who do not have it. Particularly because of the considerable number of patients in our series with hyperthyroidism and auricular fibrillation who have died of emboli, and because auricular fibrillation seems to appear more often in association with hyperthyroidism than with any other condition, we maintain that not only is this not a sound position, but that the association of auricular fibrillation with hyperthyroidism should be accepted as as indication for immediate surgical measures for the relief from hyperthyroidism. We further urge that this same position be taken with patients having the complications of diabetes or pregnancy associated with hyperthyroidism, since advancement into either of these states seriously adds to the risk of bringing about an acute thyroid crisis.

We have repeatedly emphasized what we believe to be the indications of a dangerous increase in the effects of thyroid intoxication, and have urged that in their presence emergency measures be immediately instituted if one wishes to avoid the possibility of the patient's passing into such a severe thyroid crisis that he cannot, in a definite number of cases, be rescued from it.

When patients with hyperthyroidism show a progressively rising pulse rate, the hyperthyroidism is increasing. This is likewise true when patients with this disease, in spite of a good food intake, show progressive loss of weight. When hyperthyroidism is complicated by the association of an infection, one may be sure that in a large percentage of cases the condition will be dangerously intensified. Nothing has been more definitely demonstrated to us than that infection intensifies hyperthyroidism, occasionally with startling suddenness. We have seen patients with but moderate hyperthyroidism converted within 24 hours to a condition of delirium, vomiting, and diarrhea through the occurrence of an acute infection such as alveolar abscess, or an acute follicular tonsillitis with high temperature reactions. Any change in a patient's psychic state should be accepted as an indica-

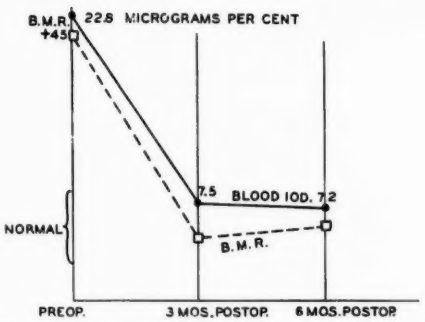


Fig. 9. Blood iodine and basal metabolism rate before and after subtotal thyroidectomy in hyperthyroidism based on 110 cases. Note the parallel average drop of the before operation elevated blood iodine and basal metabolism to normal in 110 cases, after subtotal thyroidectomy. It is this parallel drop in blood iodine which suggests the possibility that it represents the iodine fraction of the diminished amount of circulating thyroxin.

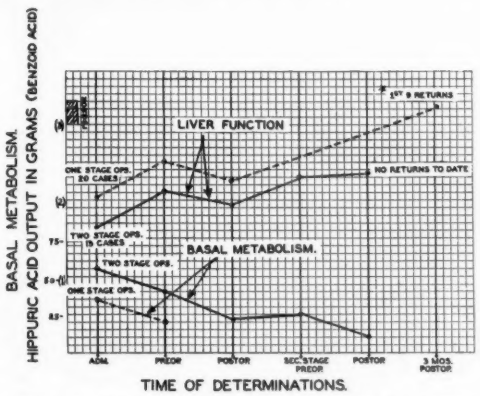


Fig. 10. Liver function studies (hippuric acid) in hyperthyroidism—comparison of one and two stage operations. Note how accurately the elevation in liver function (hippuric acid) parallels the drop in basal metabolism in the 1 stage and 2 stage subtotal thyroidectomies for hyperthyroidism. No returns are available in the 2 stage figures beyond immediate postoperative determinations as no patients of this group have as yet returned 3 months after operation. Note that the liver function is less depressed in those less severe cases of hyperthyroidism requiring but 1 stage and that this correlates with the elevation in metabolism. Note that the liver function is more depressed in those patients with severe hyperthyroidism who require two stages and that this correlates with more marked elevation in the basal metabolism. This work is as yet incomplete but is, as stated, strongly suggestive as demonstrating diminishing liver function in connection with hyperthyroidism.

tion of the onset of a possibly serious thyroid state; nothing will more certainly foretell such a state than the appearance of diarrhea or vomiting as the result either of an increase in the hyperthyroidism or of factors not associated with it. One must realize that with the appearance of these two symptoms, the most unfavorable conditions possible for this disease come into play. The combustion process associated with hyperthyroidism continues, but the ability to provide combustible fuel for this increased metabolism is lost, with the result that the patient suffers not only from the intoxication of the hyperthyroidism, but also from that which arises from utilizing his own body for fuel.

It is the failure to appreciate the real factors acting at this time that result in the unsuccessful management of so many of these cases. Everyone is familiar with the need for fluids and glucose, particularly in the presence of vomiting and diarrhea, but their intermittent employment, while helpful, is in no way comparable with the benefits obtained when they are used constantly. When fluids and glucose are given intermittently they are quickly consumed through the excessively stimulated combustion processes, leaving the patient over considerable periods of time again to burn himself. The important feature in the management of severe hyperthyroidism is the uninterrupted intravenous administration of something for the excessive metabolic processes to consume.

The best management of this state of severe hyperthyroidism is preventative; that is, to submit patients with hyperthyroidism to surgery early, before such a severe state can occur. The next best treatment of this condition is to recognize the earliest signs of its possible appearance and to introduce intravenously 40 to 60 drops of 5 per cent glucose and fluids per minute constantly day and night, together with the frequent intravenous administration of 50 per cent glucose, the patient having from 500 to 800 grams of glucose in the 24 hours. This is best introduced into the saphenous vein just above the ankle, as delirious patients are less annoyed by this and make fewer movements with their legs than with their arms. No attempt should be made to warm the solution.

We have for a number of years put 50 drops of Lugol's solution in the 1,000 cubic centimeters of fluid to be introduced intravenously, and have found it a positive, satisfactory, and safe way to get iodine into these vomiting and delirious patients.

Writers on this subject have repeatedly stressed the belief that to operate upon a patient who has recently suffered and recovered from a thyroid crisis is to court disaster. We for some years have not subscribed to this position, but believe that these patients, having been relieved of their immediate danger by the checking of diarrhea and vomiting, should be placed on a high carbohydrate diet for 2 to 3 weeks and operated upon, usually by the 2 stage method: right subtotal hemithyroidectomy, and at the end of 6 weeks, left subtotal thyroidectomy. We have operated upon many patients who have recently recovered from a thyroid crisis without an excessive mortality, thus permanently insuring them against a recurrence of their critical state by completely relieving them of their hyperthyroidism.

It is impossible in this paper, because of the very properly limited time available, to enter into a prolonged discussion of the question as to the cases of severe hyperthyroidism in which one should do a preliminary pole ligation, unilateral or bilateral, the cases in which one should do a first stage hemithyroidectomy, followed in 6 weeks by a second stage hemithyroidectomy, and the cases in which one should do a subtotal thyroidectomy. The reasons which lead us to select these various types of limited and stage operations have been set forth by myself and Dr. L. J. Schwalm in a recent article on pole ligation in SURGERY, GYNECOLOGY AND OBSTETRICS and in another paper by myself and Dr. S. F. Marshall on 2 stage hemithyroidectomy.

There can be no question as to the seriousness of the risk involved in operating upon these patients who have been in such severe states of thyroid intoxication, and while not everyone agrees with us, we are positive that preliminary pole ligation is an operation consuming less time, of lesser magnitude, and followed by less severe reaction than either right first stage hemithyroidectomy or subtotal thyroidectomy. In a recent study of our records by Dr. S. F. Marshall, Dr. L. J. Schwalm and myself, to show in what percentage of cases pole ligation and hemithyroidectomy brings about an improvement in these seriously intoxicated patients, as shown by a drop in metabolism, drop in pulse, and gain in weight, we have demonstrated that in 66 per cent of the patients who have had pole ligation and in 80 per cent of those patients who have had first stage hemithyroidectomy, there was a real and definite improvement, following these procedures as shown by convincing drops in pulse and metabolic rates, and by weight gains ranging from 2 to 30 pounds.

That these patients are often desperate risks all must admit. If one can offer these bad risks a 66 per cent chance of being improved by an operative procedure of as little magnitude (properly done with good exposure and a dry field) as preliminary pole ligation, and on 80 per cent chance of improvement with first stage hemithyroidectomy, then rarely if ever should they be submitted at this critical time to complete subtotal thyroidectomy. With the advent of iodine as a means of controlling thyroid activity, there has been a tendency to relegate stage operations to the past. As long as physicians permit patients to reach such serious states of thyroid intoxication as they still occasionally do, as long as even those who have operated upon thousands of patients with hyperthyroidism have a mortality rate, however small, we must never be governed by what is convenient or will please the patient or his friends if we are not to make a mistake as to the selection of their operative procedure. Our obligation to the patient with this disease when in advanced and critical stages is not concerned with days away from home, hospital or operative costs, business or family inconveniences, but with providing him with an opportunity to be relieved with the least possible risk of a fatal outcome. This is best provided, we believe, by multiple stage operative procedures.

I hope that these lessons and deductions drawn first hand from long and intimate experience will prove helpful to those with less opportunity of observing patients in critical

states of hyperthyroidism in such large numbers. If my remarks have done no more than indicate to you the ever present dangers of an avoidable fatality from a thyroid crisis in patients allowed to endure hyperthyroidism over too long a period of time without surgery being advised, as well as the large number of deaths from emboli in patients with hyperthyroidism, cardiac arrhythmia, and failure, and the possibility of avoiding them by accepting cardiac arrhythmia in patients with hyperthyroidism, and certainly mild or advanced failure, as an indication for immediate discontinuance of non-operative treatment and the employment of surgical measures, it will have well served the original intention of its selection as a topic. That intention was to try to reduce still further the number of patients dying or suffering serious incapacity from this disease.

## Discussion

Dr. GEORGE P. MULLER, Philadelphia: An experience based on the surgical treatment of goiter in 13,000 patients offers such a great opportunity for the analysis of details as to make the contribution from Dr. Lahey noteworthy and authoritative. I would call particular attention to the low mortality rate because too many physicians seem to think that operation for toxic goiter carries a great hazard. As will be noted, however, this low mortality rate is attained only by meticulous care in the pre-operative treatment and the selection of the type of operation.

Thyroid crisis, cardiac failure, and embolism apparently are the major hazards, and if they can be hurdled we may expect even a better chance for the patient than the 1.25 per cent—the total mortality in this series.

As Dr. Lahey puts it, "These non-operative deaths stand out vividly as a warning that whoever permits patients to suffer the effects of uncontrolled hyperthyroidism over a long period of time must accept the ever present possibility of an acute state and an avoidable fatality."

It may be that the practitioner will cure a certain proportion of the milder cases by non-surgical means, but he must become conversant with the usual progress of the disease to know that most cases cannot be successfully treated except by surgery and advise operation before his patient is enmeshed by the acute intoxication or wrecked by the irreparable damage to the heart.

The basal metabolism has been used for some years as an index of the extent of the thyrotoxic state and as an indication of the severity of the disease. All physicians now are familiar with its theory and application. A low cholesterol index is corroborative.

The newer test of the iodine content of the blood has even greater possibilities, but at present, I think, is too difficult for the average hospital laboratory. Perkin, from Dr. Lahey's clinic, has suggested an iodine tolerance test that may prove to be a valuable asset in establishing the diagnosis of hyperthyroidism.

The discussion of the relation between thyroid dysfunction and the exhaustion of the glycogen stores in the liver is based on observations extending back a number of years, but the exact mechanism by which the liver glycogen is depleted is not known. There is recent evidence that the fatty liver is vulnerable and interferes with the storage of glycogen. If we can learn how to demonstrate the existence of diffuse fatty change in the liver in the thyrotoxic patient, a line of attack is opened whereby the administration of some substance such as choline (Best) will lessen the fat content and increase the storage of glycogen.

Certainly the use of glucose before and after operation is based on sound experimental observations. Dr. Lahey's advice relative to the amount of glucose to be administered, namely, from 500 to 800 grams in 24 hours, should be remembered because generally this substance is given in insufficient dosage. It will be noted that he uses a 5 per cent solution, and as 500 grams would require a volume of 10,000 cubic centimeters of fluid, entirely too much, he uses the 50 per cent solution to step up the quantity of sugar. However, as dehyration and the glycogen content of the liver bear a direct relationship, one can give a good deal of fluid. The continuous intravenous method enables the tissues to take up the water in a normal way and eliminates "speed shock." Glycosuria should be watched for as the patient with hyperthyroidism has a faulty glucose assimilation.

I would, in conclusion, echo and repeat Dr. Lahey's advice that an avoidable fatality from hyperthyroidism can be prevented only by the recognition of the fact that long continued hyperthyroidism is responsible for the crisis, the cardiac failure, and the embolism, and that these are mostly responsible for our operative deaths.

DR. W. WAYNE BABCOCK, Philadelphia: Again we are indebted to Dr. Lahey for a dramatic lesson in the surgery of the thyroid. For years he has broadened our vision in this field, and with statistics that seem unsurpassed he has guided us to relieve little understood forms of thyroid dysfunction which often he has designated by such expressive terms as "thyrocardiac" and "apathetic goiter." Particularly are we impressed by the relative safety to which thyroid operations may now be brought. No longer are most of the deaths after thyroidectomy due to the crisis. Fatalities from such other compli-

cations as pulmonary and cardiovascular disease, compression-asphyxia (hemorrhage), and paralytic asphyxia (recurrent nerve interruption), have predominated since Plummer's iodization has become a routine pre-operative measure. In many clinics more deaths from the crisis occur without, rather than with, thyroidectomy. Without thyroidectomy the danger is often unsuspected, for previous indications of hyperthyroidism may be absent. After any operation the sudden onset of an apparently causeless tachycardia and hyperpyexia, even without thyroid enlargement, should immediately arouse suspicion and lead to the intravenous injection of iodine and glucose. An obscure adenoma, an intrathoracic goiter, ectopic thyroid tissue in the tongue or ovary, may be activated by a remote operation or by an infection. During the crisis from any cause, the central nervous system should be protected from thermal injury by adequate refrigeration. Here we should be guided by frequent rectal temperatures. The only death from crisis following thyroidectomy which I have seen in the past 3 years occurred when dependence was placed upon low temperatures by mouth, until the rectal temperature reached 108 degrees F. Refrigeration, however, should not be used routinely or indiscriminately, as it may lead to fatal pulmonary complications, especially in the aged and debilitated.

In operating upon the thyroid the method of anoci-association introduced by Dr. Crile remains invaluable. The patient should reach the operating room placidly unconscious, as from a small, not large, dose of avertin by rectum. The anesthesia should be completed by a gas, as local injections may arouse the patient and increase the pulse rate and reaction. If the pulse rate does not, as is usual, fall below 160 under complete anesthesia, a limited or stage operation is indicated. The thyroid secretion does not interfere with healing, and since we have substituted silk for catgut, wound reactions have been absent and drainage found to be unnecessary.

Are our present operations adequate? Certainly in many cases, not. In no other operation do we respect anatomy so much and pathology so little. It is customary to excise a conventional slice or wedge from each lobe rather than to remove meticulously each nodule or other bit of grossly abnormal tissue. Is it good surgery to take out half of the fibroids of the uterus? It is good surgery to remove half of the adenomas of the thyroid even when one may initiate fibrillation, a crisis, a malignancy, possibly extreme exophthalmus. Will not some of the patients we now class as cured return in later years with damaged heart and thyroid mass just as we are now meeting the procession of goitrous wrecks from the single or multiple but incomplete operations done 10 to 30 years ago? The designation "*Thyroidectomy subtotal*" is inaccurate and a poor basis for statistics. Instead let us begin now and indicate our operations something like this: "*Thyroidectomy, nineteen-twentieths removed, pathologically complete*," or, "*Thyroidectomy, two-thirds, pathologically partial* or *incomplete.*" Thus we may not only develop better methods for preventing severe recurrent symptoms, including the cardiac derangements, but we may acquire a more accurate knowledge of the relation of the pathological process in the gland to the various manifestations of goiter.

# RESECTION OF THE RECTOSIGMOID AND UPPER RECTUM FOR CANCER, WITH END-TO-END UNION

J. SHELTON HORSLEY, M.D., F.A.C.S., Richmond, Virginia

THE large figure that cancer of the gastro-intestinal tract cuts in the mortality rate of malignancies is impressive. It is estimated that there are now about 140,000 deaths from cancer a year in the United States. The last available statistics, which are for 1934, show that 134,438 deaths occurred from cancer. Of this number, 65,476 were from cancer of the gastro-intestinal tract, and 20,845 were from cancer of the bowel, including the anus. The proportion of cancers of the rectosigmoid segment of the bowel and of the upper rectum is large. In an analysis of 4,688 cancers of the colon and rectum, A. C. Broders finds that 29 per cent were in the segment of bowel comprising the rectosigmoid and upper rectum (personal communication).

Cancer of the lower rectum and of the anus may sometimes be effectively treated by irradiation, either interstitially with radon implants or externally with radium and roentgen rays, or by a combination of these methods. Cancer of the large bowel, however, certainly down to the middle rectum, is generally conceded to be a surgical condition curable only by excision.

Even in cancer of the middle or lower rectum where irradiation is sometimes effective, excision is usually indicated, preferably an abdominoperineal procedure, based on the principle of the Miles operation, with a permanent artificial anus. It is in the rectosigmoid junction where cancer frequently occurs that the problem of curing the disease and at the same time preserving function arises. Naturally, any operation for extirpating malignancy must have as its prime object curing the disease, and the preservation of physiologic function is a secondary consideration; but maintaining the normal function of the lower rectum and anal sphincter demands the utmost consideration. The patient's viewpoint can hardly be appreciated without putting oneself in his place. If you had cancer of the rectosigmoid bowel and it could be extirpated with about the same prospect for cure by two methods, in one of which the function of the rectum and anus would be preserved and in the other, a permanent artificial anus would be made, there is no doubt which of the two operations you would choose. Unquestionably, an artificial anus can be well taken care of by intelligent patients so that there is but little inconvenience. And yet, it seems obvious that if the chances of permanent cure are not sacrificed, extirpation of the cancer with preservation of anal function is preferable to an artificial anus.

The problem, then, rests largely upon whether the chances of cure are increased by removing the lower rectum and anus as well as the affected portion of bowel when the cancer involves the rectosigmoid segment. Theoretically this does not appear to be true. The rectosigmoid colon lies on the brim of the pelvis. The lymphatics from this region drain upward and there is but little tendency for retrograde lymphatic movement.

### PRELIMINARY CECOSTOMY

After the diagnosis has been established, a cecostomy is made in the right iliac fossa through a McBurney muscle splitting incision. It is highly important that the cecostomy divert all the fecal matter from the distal colon. The cecum and ascending colon are brought up through the abdominal wound and a glass rod is placed under the colon just above the ileocecal valve. A catheter is inserted in the cecum through a puncture and one or two days later the cecum is incised. A long incision is more difficult to close later on and does not add greatly to the complete sidetracking of the fecal matter, which can be accomplished through an opening of 1¼ inches

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(3 centimeters). This is made not in a band of the cecum, but in a prominent pouch. If there is any tendency for the feces to pass beyond the glass rod, a strip of vaseline gauze, doubled on itself several times and transfixed with a linen suture which is anchored, is gently inserted in the distal opening of the cecostomy where it acts as a stopper. This will prevent all fecal matter from passing over the glass rod. About 2 days after the cecostomy is established, the colon is cleaned once or twice a day with a warm saline enema and with irrigation of saline solution from the cecostomy. Immediately after each irrigation, the vaseline gauze stopper is re-inserted. In this way fecal matter can be entirely removed from the colon unless the obstruction from the cancerous growth is so complete as to convert the bowel on its oral side into a cul-de-sac. This rarely happens, but if it does, the irrigation from the cecostomy must be carefully and frequently done in order to remove the fecal matter by reverse peristalsis.

This procedure not only gives rest to the colon by removing its contents, but permits a full diet which is highly important in these patients, most of whom are rather poor surgical risks. If they are kept solely on fruit juices and candies for any great length of time, they cannot so satisfactorily recover their strength and resistance as they would if they had a well balanced diet, including proteins. Not infrequently, if there has been obstruction, a diarrhea occurs after the cecostomy. This can be readily controlled by regulation of the diet and by giving casec and such remedies as paregoric and bismuth. The resection should not be attempted until the diarrhea has been controlled for several days.

Such a cecostomy is an important preliminary step to any resection of the transverse and left colon, but in end-to-end union after excision of the rectosigmoid segment it is absolutely essential.

### RESECTION AND UNION

In the first 2 of the 3 cases reported here Steinberg's coli-bactragen was given intraperitoneally several days before the resection. It causes considerable reaction but seems to have a definite protective influence against peritonitis. In the last case the newer kind of this coli-bactragen which induces a much prompter response was placed in the peritoneal cavity at the time of the resection. This is a distinct advantage.

When the patient's condition is fairly satisfactory, usually in about 2 weeks or more after the cecostomy has been made, a resection is done. The patient is matched for transfusion of blood. The anesthetic is preferably spinal. We are now using pantocaine, which provides anesthesia for about 2 hours. An intravenous cannula is introduced immediately after the spinal anesthetic is given. Through this cannula 5 per cent dextrose in Ringer's solution is run. The blood pressure should not be permitted to fall too greatly. These patients often have damaged hearts and kidneys, or sclerotic arteries, and the intravenous injection should be watched more carefully than in younger patients. If there is an inclination for the blood pressure to rise much above normal, the rate of flow of the intravenous solution should be cut down or it should be discontinued. If the blood pressure tends to remain low at the completion of the operation, a blood transfusion is given. If the blood pressure is high, the transfusion is postponed until the blood pressure falls. Not infrequently the patient leaves the table with a blood pressure normal or even higher than normal, and there is a fall a few hours later. It is at this later stage when a transfusion is helpful or at least the intravenous injection of dextrose in Ringer's solution should be resumed. The advantages of this solution have been pointed out elsewhere.[1] It seems to be more efficient in preventing shock than salt solution.

The patient is placed in the Trendelenburg position and an incision is made along the middle of the left rectus muscle, extending from the pubis to well up above the navel. The first procedure, of course, is to examine for metastases the liver and other parts of the abdomen. This examination may cause some pain, but if it is done gently, the pain is

[1]Horsley, J. Shelton, and Horsley, Guy W. Continuous intravenous injection of dextrose in Ringer's solution. Arch. Surg., 1931, 22: 86–93. Horsley, J. Shelton. The intravenous administration of dextrose in Ringer's solution, with particular reference to its use in acute abdominal conditions. Ann. Surg., 1933, 27, October. Horsley, J. Shelton. Further observations upon the continuous intravenous injection of dextrose in Ringer's solution. Virginia Med. Monthly, 1934, May.

usually not very great. The patient should be given a hypodermic of morphine, or of morphine, cactin and hyoscine, a half hour before the operation; this helps to reduce the sensitiveness.

If the liver contains metastases which, however, are not extensive, and if the lesion in the bowel is obstructive, a resection may still be indicated. Of course, it is for the operator to decide whether the metastases are sufficiently advanced to make the resection too great a risk for the benefit to be obtained.

The small bowel is packed off with moist gauze and the point of proposed division of the sigmoid is selected. The mesosigmoid is divided from this point down to the inferior mesenteric artery. If the dissection is first made over the midline of the sacrum and is carried outward on each side, the ureters will escape injury. It is safer, however, to demonstrate the ureters, particularly the left ureter. After the inferior mesenteric artery is doubly clamped and divided—the artery being severed preferably with the electric cautery—its upper end is secured with two ligatures of catgut. If the cancer is at all advanced, it will be best to use the electric cautery freely throughout the dissection. The hand is inserted in the midline in the hollow of the sacrum and all the tissues here are lifted forward. If there is infiltration, this should be followed by cauterization of the hollow of the sacrum. The free use of the electric cautery adds somewhat to the shock and to the possibility of a subsequent peritonitis if there is any soiling, but it seems to increase the chance of a permanent cure.

From the midline the hand is shifted first to one side and then to the other, thus pushing the ureters out of the way. The peritoneum is then incised, with care to keep fairly close to the bowel. In men the cul-de-sac is difficult to expose and as the peritoneum is cut, its margins are clamped with long Kelly forceps to make it more accessible. There are adhesions and a few ligamentous attachments on each side which may be clamped and divided, or divided without clamping. Suction is preferable to sponging, though the latter is often necessary. By suction the cancer or bacteria which may be unconsciously squeezed out into the bloody serum are drawn off, whereas with gauze sponging they may be forced into the raw surface. If the dissection is difficult, the sigmoid is divided before the mobilization of the bowel in the pelvis is complete. This is done with the hot electric cautery between two clamps, and both stumps are thoroughly charred. The lower stump can be used as a handle and manipulated to facilitate the dissection.

If the cancer extends farther downward than was anticipated, the prospect of an end-to-end union must be abandoned and a diaphragm of peritoneum is made in the pelvis, after the distal stump has been shoved down. The technique for the complete abdominoperineal extirpation is then followed.

If, however, the resection can be made well below the limits of the growth, the rectum is clamped below the cancer with a right angle forceps of the Wertheim type. Usually only one clamp is placed because in this limited space the upper of two clamps may crush through diseased tissue. The rectum should be irrigated through the anus just before the division is made. With the hot electric cautery bent at a right-angle, the segment of bowel is severed *below* the clamp, the bowel having been previously packed around with moist gauze. As the rectum is divided, its margins are caught with forceps. Inasmuch as the rectum has been irrigated previously and a rectal tube left in, there should be but little contamination, but it is further cleansed by strips of gauze wet with mercuric iodide solution.

The next step is uniting the stump of the sigmoid to the stump of the rectum which lies well down in the pelvis. The lower stump has only a partial covering of peritoneum in front, and an effort is made to provide peritoneal covering at least on one side of the two approximated ends along the whole circumference of the union. With this in view, the upper stump is rotated in such a way that the mesentery of the sigmoid points to the left. In other words, it is turned through an angle of 90 degrees, which causes the surface of the upper stump, now posterior after the rotation, to be covered fully with peritoneum as it comes in contact with the posterior surface of the rectum which has no peritoneum.

Fig. 1.

Fig. 2.

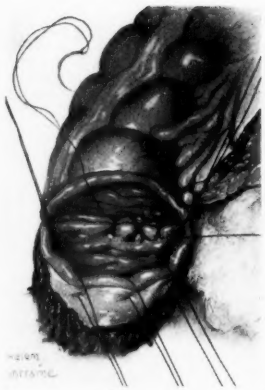

Fig. 3.

Fig. 1. End-to-end union after resection of the rectosigmoid and upper rectum. The sigmoid stump has been rotated through half a circle in order to have the posterior surface of the upper stump covered with peritoneum. Two long guy sutures of linen have been inserted through the posterior margins of both stumps.

Fig. 2. The two stumps have been approximated and the long guy or tractor sutures have been tied. Three retractor sutures are placed in the anterior margin of the lower stump but they are not tied. They serve to expose the lumen of the rectum.

Fig. 3. The posterior margins of the stumps are sutured with a continuous lock stitch of linen, catching a deep bite in the tissue.

A small rubber band is placed through the mesosigmoid about 3 inches (7.5 centimeters) above the stump. Before it is tied down, fecal matter between the band and the end of the stump is milked up above the rubber band. The rubber band maintains coprostasis and is less in the way than a soft bladed clamp. After the upper stump is packed off with moist gauze, the clamp on its end is removed and the bowel is cleaned with strips of gauze wet with mercuric iodide solution. Then a small sponge that has been dipped in a solution of iodine is pressed on the mucosa of the upper stump for about an inch (2.5 centimeters) from the end of the stump. The lower stump is similarly treated. In this way the sutures that penetrate the mucosa, which contains bacteria in its depths, are much less likely to spread infection to the surrounding tissues. The linen sutures should also be immersed in tincture of iodine solution just before being used.

Two long sutures of linen are placed as tractor sutures. The first goes from the left extremity of the posterior margin of the upper stump, from within outward, and through the left extremity of the posterior margin of the lower stump from without inward. The long ends are clamped separately. A similar suture is passed from the right extremity of the posterior margin of the upper stump through the right extremity of the posterior margin of the lower stump (Fig. 1). A good bite of tissue is taken with these sutures so that they will not pull out and will stand some tension. The surrounding gauze packing is removed, and the upper stump is so mobilized that it can readily reach the lower stump. The upper stump is then shoved down into the pelvis in contact with the lower stump, the tractor sutures being used as guides. Each tractor suture is tied three times and the ends are left long. Three sutures of linen are placed in the anterior margin of the lower stump. They are not tied, but are clamped and serve as retractors to expose the rectal lumen (Fig. 2).

With strong traction on the two original tractor sutures, the posterior margins of the two stumps are made prominent. Beginning on the left side, a continuous suture of linen in a curved needle is placed. The short end is clamped. The suture is inserted as a lock

Fig. 4. The ends of the long right tractor suture have been cut, and the continuous suture is carried forward. Pressure is made on the bowel just behind the last insertion of the continuous suture while there is traction on the suture in the line of suturing as it emerges from the mucosa of the rectum. This inverts the margin of the wound. The retractor sutures are held straight and taut, thus exposing the margins of the wound.

stitch and catches a firm bite in the margins of both stumps (Fig. 3). When the right side is reached, the suture is continued anteriorly and the ends of the right tractor suture are cut. The inner ends of the retractor sutures placed in the anterior margin of the lower stump are threaded in a needle and passed through the anterior margin of the upper stump from within outward. Each end is clamped, and as the suture is made taut, it serves to render more accessible the anterior portion of each stump. The continuous suture is carried anteriorly and is so inserted that when there is traction on it as it emerges from the mucosa of the lower stump and pressure is made on the margins of the bowel just back of the suture, the edges of the bowel are inverted (Fig. 4). As each anterior retractor suture is reached it is tied, and the continuous suture is carried along past these knots (Fig. 5). When the left extremity of the anterior margin of the wound is reached, the ends of the left long tractor suture are cut short, and the continuous suture is tied snugly to the end of this same suture which was originally clamped. In this way the bowel is united quite firmly end-to-end.

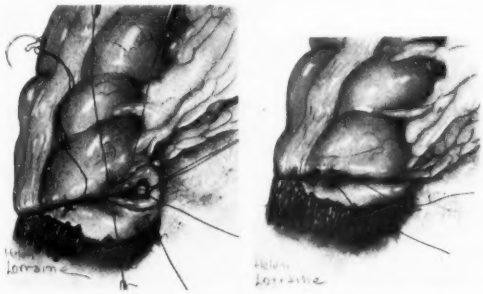

Fig. 5, left. Each retractor suture is tied and the ends are cut short as the continuous suture approaches it.

Fig. 6. The continuous suture is tied snugly to its short end which was clamped at the beginning of the suture. A series of interrupted mattress sutures of fine chromic catgut is placed around the anterior and lateral aspects of the wound as far posteriorly as possible. The ends are left long, threaded in a needle, and passed through adjacent omentum or peritoneal covered fat, and tied.

A series of interrupted mattress sutures of fine chromic catgut is placed as far as possible around the whole circumference of the bowel. Because of inaccessibility these sutures cannot be inserted throughout all of the posterior aspect of the union, but its anterior surface can be covered and a few sutures can be placed around both the right and the left borders of the union so as to encroach upon its posterior portion (Fig. 6). The ends of these mattress sutures are left long, threaded in a needle, and passed through some adjacent peritoneal covered fat. The omentum is preferable if it can reach that low, but if not, tags of appendices epiploicæ or adjacent folds of peritoneum will serve for this purpose. A cigarette drain is carried through a stab wound to the region of the hollow of the sacrum, but not in contact with the line of sutures.

In spite of precautions there is usually some infection, and in one of the 3 cases reported here a fecal fistula developed but closed in 2 weeks. The anal sphincter is divided posteriorly in order to relieve tension and a small rectal tip may be inserted.

### CLOSURE OF CECOSTOMY

About 2 weeks after the resection, if the patient is in good condition, the cecostomy is closed. If the patient is not in good condition,

Fig. 7. Drawing of the segment of the resected rectosigmoid from Case 1, Mr. J. M. A. The anterior part of the bowel tore while the resection was being made. The drawing shows that the cancer involves the whole thickness of the bowel. Posteriorly there was infiltration into the perirectal tissue.

Fig. 8. Photomicrograph of the cancer shown in the preceding figure. The acini are fairly well formed and there is some colloid. There are a few "signet-ring" cells. It appears to be moderately malignant, about grade 2½. ×115.

it is best to postpone this closure until what appears to be a more favorable time.

Formerly, in order to demonstrate patency, the expected time of closure of the cecostomy was preceded by irrigating the bowel through the rectum and through the cecostomy. This is a proper procedure *before* the resection, but it should not be done *afterward*. First of all, we must recall that the large bowel heals much more slowly and more insecurely than the small bowel. This is because of the difference in anatomic structure and physiologic function. The peritoneal covering and the blood supply are not so satisfactory as in the small bowel and the contents of the colon are extremely septic. Consequently, the union of the large bowel will not withstand the internal pressure that union of the small bowel would withstand in the same length of time soon after the suturing. Then, too, the complete disuse of the colon from the cecostomy down makes the colon contract and its lumen becomes almost obliterated. This is readily opened when the fecal current is turned on, but attempting to dilate the bowel too suddenly with hydrostatic pressure is not a physiologic method for restoring the lumen. If an enema is given, the contracted colon acts almost as though there were a complete obstruction and the chief pressure of the enema is upon the weak region of the union. Consequently, it is best not to attempt to find by enema or by irrigation from above whether the lumen is open. If the union is made in the manner described, it will hardly be possible for it to cause an early obstruction.

Two days before the cecostomy is to be closed the glass rod is withdrawn so that any fecal matter which tends to go over into the colon will not be obstructed. The cecostomy is closed first by inverting the mucosa of the cecum and holding it in place with sutures of fine chromic catgut. Then the wound in the abdominal wall is extended, and the cecum is separated from the surrounding tissue. After mobilizing the bowel and freezing the surrounding muscles in the lines of the muscle splitting incision, the wound over the cecum is again painted with iodine solution and another row of sutures of fine chromic catgut is inserted. This usually is a continuous mattress suture. Finally, interrupted mattress

Fig. 9. Drawing of segment of the resected rectosigmoid and upper rectum from Case 2, Mrs. M. K. The cancer has involved rather extensively the perirectal tissue. The dotted line below shows the apparent lower limit of infiltration. The lower stump includes much of the rectum.

sutures of fine chromic catgut are placed, the other two rows of sutures being buried. Frequently it is necessary to separate the bowel entirely from the parietal peritoneum before this last row of sutures is inserted. The cecum should be thoroughly mobilized. With the finger in the peritoneal cavity, adhesions are identified and separated so that the cecum is easily replaced. The long ends of the interrupted mattress sutures are threaded in a needle and passed through the peritoneum and the internal oblique and transversalis muscles about an inch above the upper margin of the wound. All of these are placed before any is tied. The adjacent sutures are then tied snugly together, the cecum thus being brought close against the parietal peritoneum. The parietal peritoneum and a few fibers of the internal oblique and transversalis muscles are lightly approximated with interrupted sutures of chromic catgut. No further effort is usually

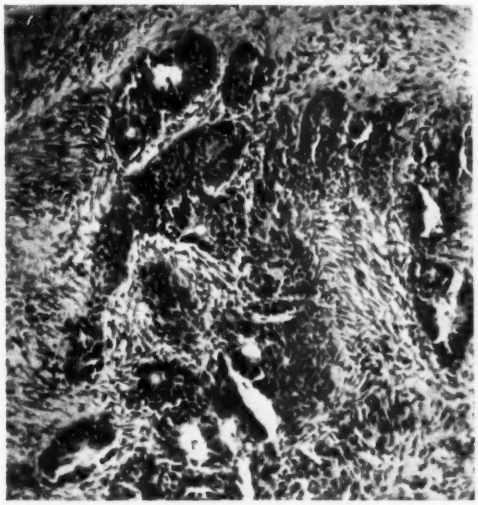

Fig. 10. Photomicrograph of the cancer shown in the preceding figure. The cells are not so well differentiated as in Case 1. The cancer is about grade 3. ×115.

made to close the wound, though one or two catgut sutures may be placed in the aponeurosis of the external oblique. The rest of the wound is packed with vaseline gauze which is removed after 4 or 5 days. There is always some suppuration, but after this has cleared up the wound granulates satisfactorily.

No enemas should be given for at least a month, but mineral oil may be administered freely through the mouth, and the diet should be, as much as is consistent with health, of the low residue type.

### REPORT OF CASES

The cases in which I have done this operation for cancer are few, being only 3. In 2 of them the cancer was far advanced, and in one it was in a comparatively early stage.

Case 1. J. M. A., man, aged 68 years. The patient had acute intestinal obstruction for which he was operated upon in his home town by Dr. H. D. Howe, of Hampton, Virginia, who did a left colostomy. Dr. Howe found a mass lower down in the colon. Thirteen days after this operation, June 25, 1934, he was removed to St. Elizabeth's Hospital and examination showed an obstructive infiltrating growth in the rectosigmoid junction which was apparently cancer. A cecostomy with appendectomy was done on June 26, 1934. Fourteen days later the left colostomy was closed and the rectosigmoid seg-

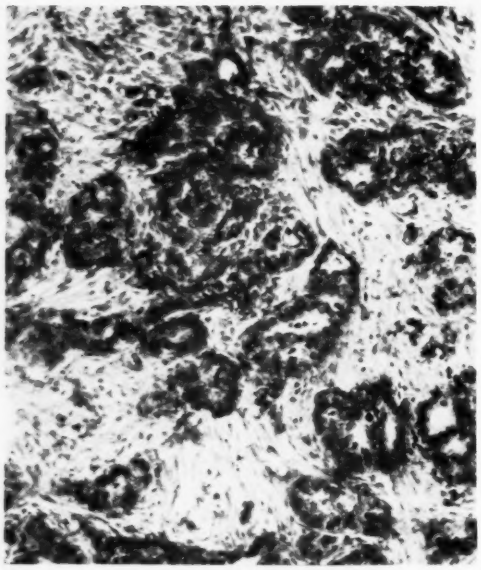

Fig. 11. Photomicrograph of the cancer of the rectosigmoid removed from Case 3, Mrs. L. G. There was a fairly early carcinomatous ulcer which measured 3 centimeters in diameter. It had not infiltrated the surrounding tissue. While there are a good many mitotic figures, the acini are fairly well formed. It is probably about grade 2½. ×115.

ment was excised, under spinal anesthesia. The growth was extensive and the cancerous bowel tore as it was removed from the surrounding tissue (Figs. 7 and 8). The electric cautery was freely used. An end-to-end union was made. August 8, 1934, the right colostomy was closed. A fecal fistula developed from the stab wound drain to the pelvis, but closed in about 2 weeks. The patient was discharged from the hospital on September 8, 1934.

For several months he was in excellent condition; he gained in weight and had normal bowel movements. Early in July, 1935, however, there were symptoms of obstruction which became worse on July 13, when I did a cecostomy, inserting a tube as the adhesions made it difficult to bring the bowel to the surface. Examination showed a large infiltrating mass in the upper pelvis. Fifteen days after the cecostomy, an attempt was made to remove the growth under spinal anesthesia, by means of the electric cautery. There was massive infiltration in the upper portion of the pelvis, including the left ureter and a loop of ileum. The ileum and a portion of the left ureter were resected, and the upper end of the left ureter was implanted in the sigmoid higher up. The lower sigmoid was also resected. An attempt was made to do a block dissection of the upper pelvis but could not be carried out. The ileum was united end-to-end, and an effort was made to bring the sigmoid to the rectum. No typical operation could be done. The patient died 2 days later of peritonitis. At the first operation the cancer was very extensive and infiltrated the surrounding tissue. But little of the rectum was involved in this second growth, most of the recurrence being above this point. It does not appear that removal of the entire rectum would have added to the chances of permanent cure of the cancer.

Case 2. M. K., woman, aged 44 years. The patient was highly nervous, having many stools each day, and suffering much pain. She had lost 35 pounds in weight within a few months before admission to the hospital. The growth could be palpated on digital rectal examination and felt like the cervix uteri. There was a mass around the uterus. On October 14, 1935, a cecostomy was done, the appendix being removed at the same time, which is the usual procedure with these cecostomies. Ten days later, under spinal anesthesia, the lower sigmoid and upper rectum were resected and an end-to-end union was made. A right ovarian cyst and an adherent chocolate cyst of the left ovary were found, both of which were removed. The cancer completely encircled the bowel and almost occluded it (Figs. 9 and 10). The cecostomy was closed on November 14, 1935, and the patient was discharged on December 12. She weighed 76 pounds when she left the hospital.

She made a fairly satisfactory recovery, though she had been taking opiates freely for some time and they were continued. A few weeks after leaving the hospital she began to improve quite rapidly; she soon gained 15 to 20 pounds in weight and felt much better. In July, however, she began to have discomfort in the abdomen and diarrhea, and she died August 21, 1936. No necropsy was held, but the attending physician says there was a mass in the upper abdomen (probably in the liver) and there was also a lump in the skin of the upper abdomen. There was no definite evidence of any recurrence in the rectum. The patient apparently died from recurrence in the upper abdomen.

This patient, too, was in an advanced stage of cancer when she was operated upon. She was nervous and high-strung, and an artificial anus would have been very repugnant to her. It does not seem that a complete removal of the lower portion of the rectum would have improved the prognosis for cure.

Case 3. L. G., woman, aged 57 years. There was a lesion in the rectosigmoid bowel that could not be palpated with the finger but could be demonstrated with the prostoscope. A cecostomy with removal of the appendix was done on May 5, 1936; the resection of the rectosigmoid segment with end-to-end union was on May 19, 1936. The cancer was in a comparatively early stage; the ulcerated lesion was 3 centimeters in diameter and apparently did not involve the perirectal tissue (Fig. 11). The cecostomy was closed on June 26. The patient had some irritation of the bladder and consequent dis-

comfort, but otherwise made a satisfactory recovery. Five days after the resection a urinary fistula developed through the drainage stab wound, but closed after 10 days. It was probably caused by pressure of the drainage material on the ureter.

The patient is now doing well and a permanent cure is anticipated.

### SUMMARY OF CASES

A résumé of these three cases shows that there was no operative mortality from the resection of the rectosigmoid colon with end-to-end union. There was recurrence in 2 of the cases, and the last patient has been operated upon much too recently to permit a claim of a cure. The first 2 cases were far advanced, and yet the first patient remained in good health for 10 months. The second patient, whose lesion was more in the upper rectum than in the terminal sigmoid, had good health for several months. It does not appear that either of these patients would have been more likely to have been cured of the cancer by a complete extirpation of the rectum. In the first patient the recurrence was chiefly above the rectum, and in the second, though no necropsy was held, there was no evidence to show that the rectum, a short stump of which was left, was seriously affected in the recurrence, and there were palpable masses in the upper abdomen.

While these 2 cases were on the border-line of inoperability, they received at least a few months of comfortable life which doubtless could not have been attained by any other procedure, and an artificial anus in one of these patients would have been extremely repugnant to her. The last patient, who is a sensitive and high-strung woman, and in whom we have reason to look forward to a permanent cure because of the early stage of the lesion, would also have found an artificial anus offensive.

### CONCLUSION

The method herewith presented for resection in cancer of the rectosigmoid and upper rectum, with end-to-end union of the bowel, is apparently as radical so far as permanent cure is concerned as complete evulsion of the whole rectum, while it offers the benefit of preserving the normal function of the lower rectum and anus. Something more than mere existence should be included in the objectives of surgery.

If the patient can be made more comfortable and life is made to seem more worth while after a procedure that offers about equal chances of cure of the cancer as other operations, it is obvious that this technique should be adopted.

## Discussion

DR. DAMON B. PFEIFFER, Philadelphia: It has been the dream of every surgeon interested in the surgery of malignant disease of the rectum and rectosigmoid to devise a plan which fulfills the requirements of adequate cancer surgery and at the same time permits restoration of continuity of the bowel. No artificial anus is equal to the natural mechanism. I am, however, impelled to interpolate right here that a well made and properly located colostomy in a well patient is easily managed. The chief and most vociferous objectors to colostomy are those who do not have them and do not need them to remain alive.

It is to be hoped that no one will advocate or condone deliberate sacrifice of sound cancer surgery for any lesser consideration. Good surgery cannot be founded upon the occasional lucky case or the unusual condition. The rock upon which most attempts at restoration of continuity have foundered has been the necessity of making adequate removal of tissue and at the same time preserving the blood supply of the bowel necessary for viability and healing. To this is added the technical difficulty of making a clean and satisfactory anastomosis between the sigmoid and rectum. That it is possible to do so is attested by many successful cases from Kraske down through Hochenegg and other great masters of the surgery of this region. That it is dangerous and difficult is likewise evident from the trend in recent years toward increasing restriction of efforts in this direction. The lowest mortalities, the highest operability rates, the greatest percentages of cures are unquestionably in the hands of those whose practice it is to perform the widest removal of tissues, involving in most instances a permanent colostomy.

Nevertheless it is not only permissible, it is obligatory in dealing with a condition which presents so many differences in pathology and anatomical arrangements, to avoid a completely standardized procedure and, when it is possible to restore continuity without undue risk, it should be done. Many procedures have been tried. I might mention Kocher's perineal anastomosis, Hochenegg's "pull through" method, Balfour's tube anastomosis, David's obstructive resection of the liberated rectosigmoid, and

Pauchet's substitution of an ileal loop. This method of intra-abdominal anastomosis, so well organized in detail by Horsley, is not new in principle. All these methods have given successes as well as failures. They are all more difficult and more liable to serious complications than colostomy and resection.

More difficult than the surgery, however, is the selection of cases appropriate for the attempts. Obviously the cases should be early, preferably without recognizable penetration of the bowel or metastasis at a distance. To my mind also such procedures should be limited to growths which are located on the sigmoidal side of the rectosigmoid. It is true that the recent work of Villemin, Huard, and Montagné on the lymphatics of the rectum indicate that the lymph channels of the rectum above the lowermost valve of Houston normally course upward, but it seems excessively hazardous from the standpoint of recurrence not to excise the rectum at least as far down as the lowermost valve in every growth involving the upper ampulla; this renders the difficulties and dangers of subsequent anastomosis within the abdomen almost prohibitive. Also it is not so uncommon for retrograde metastasis to occur in carcinoma of the upper rectum. It is equally true that the rectum should be transected well below the rectosigmoid junction in any attempt at anastomosis because only in that way can the surgeon be sure that the lower segment will receive sufficient blood supply from the poor anastomosis between the superior and middle hemorrhoidal vessels. Here is, indeed, almost a dilemma.

It is well known through the researches of Sudeck, Archibald, Mondor, and others that the mobilization of the sigmoid to bring it downward with safety to the point of anastomosis depends upon the preservation of the anastomotic arches which supply the straight arterial vessels to the bowel. Mobilization of the bowel itself and unrolling it to obtain length by dividing the mesentery radially is simple enough, but unless the greatest care is exercised, one may divide the anastomotic arches upon which viability of the sigmoid depends. Mobilization must be accomplished by dividing not only the inferior mesenteric artery but also the lower sigmoid artery or arteries near their points of origin above the pelvic brim and by unfolding the mesentery cautiously in such a fashion that the marginal arch is not broken. Anatomical conditions will sometimes favor, sometimes entirely prohibit, this attempt.

In my earlier experiences with carcinoma of the rectum and rectosigmoid, I tried a number of expedients to restore continuity, but my results were such that I felt that the occasional successes did not counterbalance the increased morbidity and mortality, as contrasted with frank adoption of permanent colostomy in all but highly selected cases. Of course, the uncontrolled perineal colostomy is infinitely inferior to the abdominal anus in all respects except sentimental nonsense. Nevertheless we need to be reminded that there are still cases, and we hope for more as earlier diagnosis shall become more popular, in which restoration of continuity will be possible and practicable. It is indeed true, that a colostomy is sometimes the price which a patient must pay for late diagnosis and delayed action.

This operation as described by Horsley is well considered and founded on correct surgical principles. The complete diversion of the fecal current is a prerequisite to success. The many details necessary for the second stage presuppose not only a command of technique, but a profound knowledge of the pathology and surgery of carcinoma of the rectum and rectosigmoid. This procedure represents one of the variants of operation available to the masters of surgery of this region but not to be considered as a type or pattern for the average case or the average surgeon. Fortunate is the patient to whom it can be applied. Happy is the surgeon who can carry it out successfully.

Dr. Walter Estell Lee, Philadelphia: Dr. Horsley's paper is intriguing in many ways. First in calling attention to the fact that of the 140,000 deaths occurring from cancer in the United States in 1934, 31 per cent involved the gastro-intestinal tract, 23 per cent of these occurring in the colon, and that 29 per cent of the tumors involving the large bowel were found in the rectosigmoid or upper rectum. Appalling as these figures appear, they do not seem to be as great as one would expect from the steadily increasing number of patients entering our hospitals with these lesions. Carcinoma of the colon, rectum and sigmoid is undoubtedly becoming more and more of a major problem for the surgeon, and such a contribution as this from Dr. Horsley is timely. His meticulous description of a technique proposed for this procedure makes interesting and stimulating reading, and its possibilities certainly will appeal to every surgeon who has had any experience with this problem.

We would like to emphasize his definite statement, that in the resection of the large bowel one must expect healing to take place much more slowly and to be more insecure than in the small bowel. This is because of differences in anatomical structure, physiological function, blood supply, and the contents of the colon, which are more septic. Appreciation of these inherent difficulties of an end-to-end anastomosis of the large bowel serves as a red signal to surgeons when they consider the possibility of a conservative resection in cancer of the rectum.

I do not believe that many surgeons will disagree with Dr. Horsley's statement that, granted it is possible to remove completely a malignant growth of the rectum by local resection and to re-establish safely the fecal current by end-to-end anastomosis of the divided bowel, such a method is more desirable than a radical resection of the growth, the rectum, and the perirectal tissues, and the establishment of a permanent loin colostomy. Further, I think we can put it even more strongly by saying that probably no patient would permit a loin colostomy if he felt that it was possible to avoid it by having a conservative instead of a radical opera-

tion. The choice between these procedures, in the last analysis, must be made by the surgeon, and usually against the wishes of the patient, but up to the present time we must admit that in the large majority of cases such a conservative plan as Dr. Horsley describes is not applicable to malignant growths of the sigmoid and rectum. Dr. Horsley, of course, does not claim that the 3 cases which he presents is sufficient evidence that his procedure will greatly increase the proportion of cases in which a permanent colostomy can be avoided, for there were recurrence and death in his first 2 cases in about the usual length of time, and only 5 months have elapsed since his operation upon the third case.

While we do not wish to minimize the disadvantages of a life with a permanent colostomy, there are a great many other handicaps with which we leave our surgical patients which are more embarrassing and difficult to bear. As a matter of fact, it is a constant surprise to us to see the way in which most patients adapt themselves to this situation, and we are convinced from our personal experience that unless one can be reasonably sure that conservative resection of the growth and an end-to-end anastomosis will offer as good a chance that local recurrence and metastasis will not occur as the radical operation offers, a surgeon has no right to compromise with the patient's pre-operative attitude toward a permanent colostomy. Certainly the surgeon should not make such a compromise without informing the patient fully that there is probably an increased risk to him in the conservative procedure, and such an operation should not be done without the patient's full consent.

Perhaps the only contribution that we can make to this discussion is to emphasize that in our experience the patient's adaptation to a life with an artificial anus is not so difficult as is generally supposed, and that when properly made and properly cared for, which means the discarding of the filthy colostomy bag, it is possible to carry on a normal life without embarrassment to one's family or friends. I recall one patient in particular, a woman of unusual refinement, who for more than 3 years has been attending to all of her many social duties just the same as she did before operation, and indeed is far more active than most of her friends of her age, and no one is conscious that she is carrying on with such a handicap. Our definite feeling is that, desirable as it may be to restore the fecal current by end-to-end anastomosis, such an indication should not, with the positive evidence at hand, influence our judgment in the choice of the operative procedure in a particular case, if there is a greater chance of recurrence and metastasis with the conservative procedure than there is with the radical.

As to the details of the technique which Dr. Horsley has so carefully and meticulously outlined, we feel sure that it will appeal to others as it has to us, and in the near future we know we shall be tempted to try it when a suitable case presents itself in which the patient will be willing to assume the possible or certain added risk in order to avoid the inconvenience of an artificial anus.

# TRANSURETHRAL RESECTION, ITS INDICATIONS, LIMITATIONS, AND COMPLICATIONS

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NEW therapeutic measures, like new political theories, are invariably adopted enthusiastically by those who desire to be the first by whom the new is tried and who abhor the thought of being the last to lay the old aside. The merits of many new procedures are often offset by the lack of skill and training of these inexperienced enthusiasts, and can only be established by that wasteful but, in the end, effective method of trial and error. Transurethral resection of the enlarged prostate is no exception to this rule, as a brief review of its development will indicate. At the same time, by familiarizing ourselves with its past limitations, we may best appreciate the present limitations of this procedure.

## LIMITATIONS

The procedure was first carried out in 1837 by Mercier of France. He attempted, by removing portions of the enlarged prostate through the urethra, to restore to the aged male an adequate channel through which he might empty his bladder without being subjected to major surgical procedures, which left his survival in doubt and by no means assured relief. At that time such a procedure had very definite limitations, for unless all obstructing tissue was removed, the patient's condition was made worse rather than better, and the amount of tissue which could be removed was limited by the amount of bleeding produced and by a lack of adequate vision. Today those limitations have, to a great extent, been happily overcome, but the principles upon which they were based are as fundamentally true today as they were in the time of Mercier.

Free, adequate, and unobstructed drainage of the urinary tract is the basic principle of all forms of urinary therapy. When this is disregarded, either in the performance of surgical procedures or in the administration of urinary antiseptics, discouragement, disappointment and not infrequently disaster, result. Prostatectomy, both suprapubic and perineal, have as their fundamental principle the restoration of adequate urinary drainage; and in proportion as the perineal approach developed by Dr. Young gave more perfect drainage immediately following operation, so has the mortality rate of that procedure been lower than that of its rival, the suprapubic enucleation. Transurethral resection is simply another method of accomplishing the same end, namely, the restoration of urinary drainage; and upon its effectiveness in attaining this primary object depends its success or failure.

With the development of electric currents, attempts were made to destroy the obstruction in the urethra by the galvanic cautery. The instruments of Bottini and Luy were of this type, and both failed because they disregarded the first law of urology that manipulation and trauma in the urinary tract are safe only when subsequent complete drainage is afforded. The obstruction not being completely removed, the cauterization produced secondary edema, inflammation, and obstruction, with its serious sequelæ, as it still does today under similar circumstances.

The amount of tissue which must be excised to insure complete emptying of the bladder varies greatly, but in many cases it is not large. The prostatic urethra is of small diameter. An insignificant amount of hypertrophied tissue can produce a major degree of obstruction, while huge hypertrophies have been known to interfere but slightly with the urinary outflow. In 1909 Dr. Young deplored the necessity of subjecting those of advanced age to major surgical procedures, in order to remove from the posterior urethra what frequently amounted to an insignificant

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amount of obstructing tissue, and that year he presented at the International Urological Society meeting the instrument that was to become known as the Young punch, and which served during the next decade not alone as the best instrument for the transurethral removal of obstruction, but as the model upon which many subsequent instruments were constructed. Its limitations were approximately those of Mercier's instrument, for although a reflexed light was thrown down the lumen of the instrument, its closed end prevented from being seen any structures which did not project into the fenestrum. Once the initial incision was completed, the resulting bleeding made all structures appear identical. Because it provided no means of controlling bleeding following excision, the amount of obstruction that could be removed was exceedingly limited. This limitation was first overcome by Dr. Caulk. He adapted a cautery blade to the tubular knife of the Young punch, so that it cauterized as it cut, thus diminishing considerably the amount of bleeding. He believed that obstructing prostatic tissue could be successfully removed through the urethra without the necessity of a major surgical procedure, and he persistently presented this belief before the seats of the scornful, demonstrating it for many years by the increasing number of his own cases thus treated. Those now being relieved of their urinary obstruction by transurethral methods owe no little debt to Dr. Caulk's pioneering work during the years of general skepticism. However, vision (in his instrument) remained as limited as in the Young punch, and the inexperienced were naturally reluctant to work under such a handicap. In the meantime, those who were using the direct cystoscope, as developed by Dr. Braasch, were, with his co-operation, so modifying the instrument that tissue could be excised under direct vision with a tubular knife. The bleeding which interferes with vision very little in a direct cystoscope, I found, could be controlled by electrocoagulation of the individual vessels after each excision, and I have always believed that by adhering to the principle of excision with a knife, and confining the application of the high frequency current simply to the control of bleeding, destruction of tissue is kept at a minimum and subsequent healing will be more rapid. This is borne out by the fact that the average postoperative hospital stay of my private cases has been 5½ days, as well as by the fact that 58 per cent of the cases at the Mayo Clinic, where I developed this technique, left the hospital within 7 days. However, this technique is little used elsewhere, because most urologists are trained only in the use of lens instruments which demand a clear irrigating fluid, and as bleeding must be controlled at the time of excision to insure vision, the current is employed for the purpose of excision as well as for hemostasis. The manufacturers who had adopted the then recently perfected high frequency cutting current to use under water, at the suggestion of Stearns, incorporated within a lens cystoscope a reciprocating loop which was capable of excising strips of tissue from the prostatic urethra under the visual guidance of the operator. T. M. Davis was the first surgeon to operate upon any considerable number of patients with this instrument. In May, 1930, he reported 128 cases so treated, concluding his report with the remark: "The operation of resection is a minor one with practically no mortality" (no mortality in the author's series), "with results that are as satisfactory as those obtained with major operations of prostatectomy with its rather high mortality." The urological profession was both impressed and skeptical. The manufacturers, however, were quick to improve the Stearns instrument by changing the position of the loop and incorporating the unexcelled McCarthy foreoblique lens system. Then, for the first time, the profession was supplied with an instrument capable of unlimited excision of tissue under adequate vision. The sale of some 2,500 of these instruments indicates how general is the belief that there is no limitation to the applicability of the procedure. The fact that Caulk, Davis, and the other pioneers in the development of transurethral surgery had perfected their technique only after long years of experience in manipulative cystoscopy was disregarded. Many gazed upon the interior of the bladder for the first time through their new resectoscope and attempted the removal of

what they believed was obstructing prostatic tissue. That the results of such efforts proved disastrous was to be expected; that they brought into disrepute a new method of restoring adequate drainage to an obstructed urinary tract is to be regretted. The prostatic urethra, while small in its dimensions, is rich in its blood supply, and, when the larger vessels are opened, the bleeding can rapidly obscure the field of vision so that the operator seems suddenly to be looking through a ruby-colored haze. In his efforts to control this bleeding, he is likely indiscriminately to coagulate inadequately visible areas in the forlorn hope of encountering the source of the blinding hemorrhage. When one thinks of how essential to good function and even to life is the integrity of the structures adjacent to the prostatic urethra, it is readily appreciated how easily under such circumstances irreparable damage can be done. In other types of surgery, errors in technique, although regrettable, can usually be remedied. An incised artery may be repaired, a perforated bowel sutured, a cut ureter ligated or transplanted, but a single mistake in excising tissue beyond the anatomical boundaries of the prostate is irreparable. Urinary extravasation or rapidly developing peritonitis, to say nothing of fatal hemorrhage and complete urinary incontinence, are the certain results of such errors. It is not difficult for the inexperienced so to undermine the trigone of the bladder that in a few hours' time the bladder is floating like a cork in the extravasated urine. The external sphincter's position directly at the apex of the prostate makes its partial excision with a cutting-loop electrode most easy, while the small opening of a basal diverticulum or dilated ureteral orifice can so simulate an internal urethral sphincter as to trick the novice into unintentionally attempting their resection.

All these disasters, and many others, have occurred, not once but many times, not to mention the cases in which bleeding has resulted fatally in spite of packs and transfusions. That such regrettable accidents should not be attributed to the operation but to the inexperience of the operator, seems evident when we learn that Davis operated on 966 patients with but 7 deaths, only 2 of which occurred in his last 500 cases; while Thompson and his associates at the Mayo Clinic performed resections in 679 cases last year with but 7 deaths. I have cited these 2 resectionists because, while they use different types of instruments, their results are similar. One employs an electrified wire loop for excising his tissue; the other uses a tubular knife. The factor which constitutes the *greatest limitation* of this procedure is not the instrument used, but *the training of the operator*.

Of what serious concern this limitation is to the profession is, I feel, not fully appreciated. We advanced in proportion as we were capable of utilizing new methods of proved value. The mortality rates just cited, when compared with those associated with prostatectomy, indicate that this more technical procedure is decidedly preferable, especially when its brief morbidity is considered, and it should be evident how necessary it is that the special training required to master this technique be more generally available. One can, as regards most surgical procedures, learn by assisting the senior surgeons, but when an instrument of the caliber of a cystoscope is used, there is little one can learn from assisting.

The surgeon's experience comes of necessity from his own performance of the procedure, and before this is permissible he must, by innumerable examinations with the cystoscope, have familiarized himself with the ever different anatomical aspect of the bladder neck produced by the various degrees of prostatic enlargement. Such opportunity is today available to the comparatively few who can devote years of training to their chosen specialty in large urological clinics. Figures such as those compiled by Orr this year show that the mortality rate associated with transurethral resection bears a direct relationship to the experience of the operator. From 5 urologists, each of whom had operated in more than 500 cases, he reports a mortality rate of 1.9 per cent for the 4,767 cases in which they had operated, while 25 others each of whom had done between 100 and 200 reported a mortality rate of 4.1 per cent for their 3,530 cases.

INDICATIONS

With the introduction of such a radical departure in the treatment of prostatism, it is natural that considerable confusion exists as to the indications for its application. Those surgeons who have developed a satisfactory technique for either suprapubic or perineal removal of the gland, naturally believe that this newer method of treatment should be employed in cases presenting little obstruction and requiring the removal of but a small amount of tissue, thus saving the less advanced cases from major surgical procedure with its greater risk and prolonged hospitalization. The early warnings of Collings, who developed the first efficient means for cutting under water by the use of a high frequency current, that transurethral surgery should never be employed in cases of adenomatous hypertrophy, were readily accepted by many. Others consider that this newer method of treatment is but a glorified Young's punch operation, and as he advised, should be confined to the revision of contracted bladder necks and median lobe obstruction.

It would seem more logical to take a broader view, recognizing that the fundamental difficulty is the obstruction presented to the urinary outflow, and to evaluate the indications for this newer method by its effectiveness in removing such obstruction, rather than to state arbitrarily that up to the removal of so many grams of tissue the procedure is applicable, but that beyond this amount enucleation is indicated. Some have even tried to classify its indications by the amount of residual urine present, depending on the number of cubic centimeters found, as an indication for complete enucleation or transurethral excision, overlooking entirely the fact that the position of the obstruction in relationship to the lumen of the urethra determines the amount of residual urine as well as the degree of obstruction.

If, by transurethral means, normal bladder function can be restored, then the indications for the employment of the technique naturally depend on the risk which is involved in its performance. If it could be demonstrated that this risk increases in proportion to the size of the gland, then logically the procedure should be confined to the lesser degrees of obstruction. A review of reported cases does not indicate that this is true. As recently as July, Thompson reported in detail 200 consecutive cases in which 25 grams or more of prostatic tissue were removed with a mortality rate of 1.5 per cent. The average weight of an enucleated gland is between 35 and 40 grams, so it can be seen that in most cases the excision of from 15 to 25 grams of tissue will remove the obstructing portion. The transurethral resection of this amount of tissue should in the majority of cases be easily removed in considerably less than an hour's time, for the removal of vastly greater amounts of tissue (ranging to over 100 grams) at a single operation is recorded. The large hypertrophies, if they are subjected to resection, will usually require more than one session for their complete removal, and the time consumed in the hospital will be approximately that consumed by the older methods. The lessened risk of the new procedure then becomes its only advantage in removing these huge hypertrophies, but one which seems to appeal to the increasing number of patients seeking relief by resection. It is doubtful if the huge hypertrophies which adorn the shelves of our museums will long be encountered. They will, I believe, go the way of the equally remarkable ovarian cysts which at times weighed more than their host, but which now never have opportunity to form because of their earlier removal. The greatest number of patients undergoing prostatectomy at the Mayo Clinic in a single year was less than 275. Last year 695 were resected at that institution, and up to September 1, 1936, there had occurred a 20 per cent increase over the 1935 figures. This increase in the number of patients treated by this new procedure both at this institution and elsewhere has been interpreted by critics of the procedure as indicating that many younger patients are subjected to resection who would formerly have been refused prostatectomy because the obstruction was insufficient to demand surgery. A careful examination of the reports of these institutions and of Dr. Alcock's Clinic at Iowa City refutes this argument; the average age of 600 patients whom he formerly treated by prostatectomy was 66 years, while that of 700

whom he treated by resection was 73 years. Today, many patients who formerly would have been refused treatment because of their poor physical condition are now successfully relieved by transurethral means and account in no little measure for the increased number treated. Thompson states that 274 of the patients treated last year at the Mayo Clinic were suffering from complete urinary obstruction, or had overflow incontinence, certainly supportive evidence that in at least some of these cases the disease was far advanced. Some have held that the procedure was chiefly indicated where urinary obstruction had been of such long standing that the resulting cardiovascular renal damage would not permit of any major surgical measures for relief. That the operation is well borne by those of advanced age is indicated by the 38 patients of over 80 years of age included in the Mayo Clinic figures for last year, all of whom survived. Yet we read Twinem's recent report that the mortality for 33 patients over 80 years of age treated by prostatectomy was 33⅓ per cent! It has always been difficult for me to understand why a surgical procedure that is considered safer for the debilitated is not equally safer for the more vigorous. The fact that resection involves less risk than prostatectomy has lessened the time consumed in the preparation of these patients for surgery. Where formerly the principle of adequate free drainage of the urinary tract had to be employed in their pre-operative preparation, either by the use of an indwelling urethral catheter or suprapubic drain, now, by the complete removal of the obstruction through the urethra, this fundamental factor of drainage is at once established and the patient during his convalescence makes the gains that were formerly expected preparatory to surgery. I do not mean to imply that pre-operative preparation is no longer required in all cases, but the number in which it is found necessary in order to get the patient in sufficiently good condition for transurethral excision of the tissue is probably only one-tenth as great as was required when the enlargement was to be enucleated in its entirety.

In the Mayo Clinic series just referred to, 65.7 per cent of the 695 patients received no pre-operative preparation, and in my private cases I find that only 20 per cent received pre-operative preparation.

### COMPLICATIONS

Why, then, is the procedure not more generally employed, and why do so many fair-minded observers among the profession still express grave doubts as to its efficacy except in a very limited field? Having developed the technique, and having introduced the procedure at a surgical clinic, I feel qualified to answer this question: *Because of its post-operative complications!*

On all surgical services, due to the untiring effort of this association, the best methods of treatment for a given condition have become well standardized, as has the after-care of surgical cases. Therefore, the surgeon may expect his greatest difficulties to occur, in most cases, during the course of an operation, and once the last line of sutures is placed (while he may worry as to the outcome of the case), he is confident that what complications may occur are bound to be met by the hospital personnel in an established manner. In the case of such a comparatively new procedure as transurethral resection, methods of post-operative care have not been so well standardized. There is no external wound with its associated dressing to impress upon the nursing staff the seriousness of the operative procedure just completed, and catheters are likely to be regarded with distaste and examined as seldom as possible, especially if their source of origin is the male urethra. The fundamental principle of free and uninterrupted drainage of the urinary tract, if appreciated at all, is usually totally disregarded until the bladder has become distended to the point of extreme discomfort, at which time the nurse does not usually seek to relieve the obstruction but starts on a prolonged and often futile search for an orderly. In the interim, there has occurred a reflux of infected urine to the renal pelves, the operative site has been stretched, and bleeding points adequately coagulated at the time of operation have torn open and are bleeding freely, so that to exsanguination are added the perils of impending renal sepsis, a combination that has only too frequently

proved the undoing of the most conscientious surgeon.

Once a sufficient number of patients are operated upon by this new method to insure the special training and complete familiarity with the care of tubular drainage during the first 48 hours after surgery, the chief hazard of the procedure will be eliminated. The popularity of the method in the larger urological clinics bears this out. The procedure itself is tedious and tiring. There is little to admire in the operator with his eye glued to an instrument that at irregular intervals more or less completely showers him with hemorrhagic fluid. He is not a heroic figure in his position; in fact, he at times seems hardly worthy of respect, as he labors in his dampened atmosphere to remove in small pieces, over a considerable period of time, what his brother surgeon grandly enucleates in but a few minutes. Some one has tritely remarked that prostatectomy is an operation which is hard on the patient but easy on the operator, while transurethral resection is trying for the surgeon but easy for the patient. Tedious and exacting as the operative technique is, the after-care of these patients demands the utmost in constant observation and untiring watchfulness of their urinary drainage. If the operative procedure has been correctly performed, a comparatively insignificant break in postoperative care may turn what should be success into failure. If a patient bleeds after suprapubic prostatectomy, there is always a suprapubic opening through which clots may be exuded and pressure relieved; not so in the resection case. If the catheter or urethra becomes obstructed by even a small clot, when the bladder fills it will contract in an attempt to expel it, ineffectual spasms of the bladder musculature will develop, and the bleeding, which was at first insignificant, becomes aggravated. More clots form, which the bladder tries vainly to expel, and so a vicious circle is established which might have been prevented by the prompt opening of the obstructed catheter when first occluded. In such a case there is nothing to be gained by watchful waiting in the hope that the bleeding will stop. It will continue until the bladder has been cleared of clots, and usually on their evacuation the bleeding ceases spontaneously. To the inexperienced, bleeding is a formidable and serious matter necessitating transfusions and even cystotomy. The stopping of such bleeding by transurethral methods requires the maximum of technical skill, and those who have not attained such skill will resort to opening the bladder suprapubically. To have informed a patient of the benign nature of transurethral resection, and, having undertaken it, to be compelled to perform a suprapubic cystotomy after an ineffectual attempt to control postoperative bleeding, is likely to cool the ardor of the most enthusiastic resectionist. But if the axiom that an empty bladder is the best insurance against hemorrhage has been conscientiously followed throughout convalescence, such trying experiences will prove rare. The male urethra, while intended for a dual function, was never designed as a receptacle for surgical instruments, and it resents their presence. Therefore, the utmost care must be taken to reduce its trauma to a minimum, and nothing so increases trauma as the undue prolongation of the operation. If sufficient tissue cannot be removed within an hour, it is far better to give up and return another day, than to continue. After a 4 or 5 day interval, the patient will usually permit completion of the operation with even less reaction than at the first procedure. Protective barriers are evidently thrown up in the adjacent prostatic tissue, and absorption of toxic and septic material is demonstrably less. To cause a urethral stricture by too prolonged instrumentation is to establish an incurable obstruction in place of a removable one. Yet the inexperienced surgeon is likely to feel that his professional standing depends upon the completion of the procedure at a single operation, and by so traumatizing the urethra, he injures his reputation for all time by the incurable stricture which he has produced. It seems hardly necessary to add that passage of too large instruments, or insertion of too large caliber catheters after operation, can produce the same effect.

## CONCLUSION

Records are now available of some thousands of cases demonstrating that with proper

care and careful technique, transurethral resection offers the lowest mortality rate and the shortest hospitalization of any method for correcting urethral obstruction resulting from prostatic enlargement. Its indications are the need for restoration of normal urinary drainage, its limitations, those of the operator's skill, and its complications, the result of inexcusable neglect or gross deficiency in technical training.

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## Discussion

Dr. Alexander Randall, Philadelphia: The subject of transurethral resection may be discussed from four distinct angles, but at this time I wish to dwell upon the cure of the pathological condition present. In the beginning let us record certain facts on which all agree. First—the modern instruments, with the application of the new electric currents, have made obsolete all previous models for vision, accuracy, hemostasis, and the amount of tissue removable therewith. Second, in median bar obstructions urethral resection is, and should be, curative. So was the punch. Third, in carcinomas it is relieving pitiful distress and suffering, and postponing in comfort a lingering death from urinary infection, vesical hemorrhage, tormenting dysuria, and gradual renal failure. This leaves us alone true prostatic hypertrophy; and into this clinical and pathological state the resectionist is entering with claims to which I do not subscribe. From my pathological studies I have pointed out the varying degrees and varying types that prostatic hypertrophy may present. Again, let me make myself clear; for in those small hypertrophies, especially those that involve only the lateral lobes, those with isolated median lobes (Albarran's) and those with beginning posterior commissural hypertrophies, I practice resection, age and residual urine being no criteria. But, when faced with the typical grade 2, 3, or 4 hypertrophies, I consider open prostatectomy safer.

Let me welcome the addition of transurethral resection to our surgery. It has broadened our ability to cope with the prostatic problem; it has enabled us to differentiate and select the best type of procedure in the properly studied cases; it has wonderfully safeguarded previous hazards of similar operative approaches; it is curing median bars; it is prolonging in comfort the life of the cancer patient. But, when it disregards the gross anatomy of the prostate in hypertrophy; when it advocates the abandonment of the cardinal principles of preoperative preparation upon which prostatectomy has been made safe; when it makes a planing mill of the varying surgical pathology of benign hypertrophy; when it palliates symptoms; when it prolongs the operative ordeal; when it requires repetition for even a questionable cure; when, in inexperienced hands, or in ill-advised cases, it is creating incontinent sphincters; when it alone is responsible for vesicorectal fistulas; when perhaps more patients are living, though many wish they were dead; then I refuse to harken to its siren call, and until offered greater assurances than are available now in these particulars, I will continue to prefer to individualize the patient, to individualize his pathology, and to individualize his pre-operative preparation and his postoperative care, especially as regards free and unhampered drainage, selecting in each case the operative method that gives greatest promise of a prompt, a safe, and a permanent cure.

Dr. David M. Davis, Philadelphia: I agree heartily with Dr. Bumpus' contentions that prostatic resection is a good and safe operation and a tremendous addition to the urological repertoire, that evil results are usually the result of incompetent performance, and that long and earnest striving for complete cystoscopic proficiency should be required of everyone before he attempts his first resection. Most unfortunately, this procedure is considered by a great many physicians as still on trial because of the question of its safety. The figures presented by Dr. Bumpus ought to convince even the skeptical that this operation is the safest of the safe when performed by skilful and experienced hands, and I see no reason why I should add anything to his remarks on this score. I should prefer to discuss prostatic resection from the point of view of results obtained; certainly this is the most important element for the patient.

The only serious complaint I have against prostatic resection in the treatment of prostatic hypertrophy is the difficulty encountered in a good many

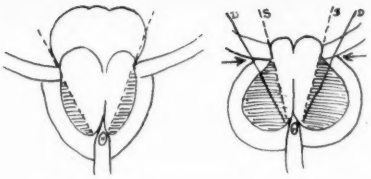

Fig. 1. Left diagram illustrates prostate suitable for resection. Right diagram small prostate, but not suitable for resection. Dotted lines marked *S* indicate safe limits for resection. Solid lines *D* represent the depth at which there is danger of extravasation.

cases in obtaining a really good result—that is, clear urine with no residual, and normal bladder capacity. No matter how firm and tense an enlarged prostate may be, it is not a rigid and inflexible mass which retains indefinitely the shape given it at the resection table. The elastic, nodular tissue making up that part of the hypertrophied mass which is left behind promptly re-arranges itself, and the fine channel created by the resectionist provides the direction of least resistance. Halved spheroids re-assume their rounded contour, and the urologist finds the prostatic urethra again filled with a multitude of irregular masses, often causing as much obstruction as before. There is nothing to do but to resect again, and the result will be the same until such time as the hypertrophic tissue left behind is so small in amount that it can no longer seriously encroach upon the prostatic urethra.

Which cases are suitable for resection? Any small hypertrophy, of whatever type, is suitable. In medium size hypertrophies, the conformation of the growth appears to be most important. If it is approximately cylindrical, or if the diameter of the upper and intravesical portion is greater than that of the lower and extravesical portion, it can probably be handled satisfactorily by resection. If, on the other hand, the lower extravesical portion is larger than the upper part, with small intravesical growth, little or no dilatation of the internal sphincter, and a tendency for the extravesical portion to bulge sharply into the rectum, there will be greater difficulties in the way of a good resection. Figure 1 illustrates this relation.

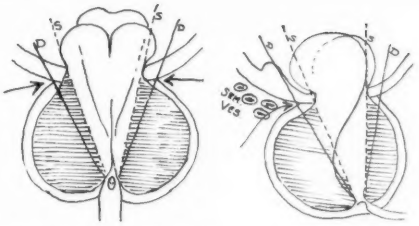

Fig. 2. Diagrams illustrating why large, bulging, extravesical prostates are not suitable for resection. If cutting is kept within safe limits, large amounts of tissue are left behind.

Very large prostates—let us say 75 grams and over—are, I believe at present, entirely unsuitable for resection except possibly when one wishes, in a very poor risk, to insert a suprapubic drain and then resect the prostate piecemeal in many sittings. Figure 2 illustrates some of these reasons. One must remember an ever present danger. The larger the hypertrophy, the thinner will the capsule be, and every surgeon has seen cases in which it was only 1 or 2 millimeters thick. Too vigorous efforts to remove all the hypertrophy may result in perforation of this attenuated capsule.

I am not quite as pessimistic as Dr. Bumpus about prostatectomy. The modern perineal operation, with carefully placed sutures of the capsule, is free of danger from hemorrhage or shock, and has a mortality rate in the same category as resection.

I must disagree stoutly with Dr. Bumpus in the matter of pre-operative preparation. While many patients need no preparation for either resection or prostatectomy, those who do are definitely in peril, and I do not see how we are justified in taking chances with them even if the chance is slight. The object of preparation is to get the patient in the best possible condition, and this should be our aim regardless of the method of operation to be used.

In closing, may I say that I believe that modern urologists, and especially the urologists now in training, are under the obligation of learning to be equally proficient in all the methods of operating on the prostate, so that they can choose without prejudice the method best suited to each case.

# RADIUM VERSUS WERTHEIM'S HYSTERECTOMY IN THE TREATMENT OF CARCINOMA OF THE CERVIX

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THE dread disease of modern civilization is cancer. There is no family which has not suffered from it; there is no individual who does not fear it. Until the cause is discovered our treatment must be empirical and unsatisfactory but, although the outlook at the present time is gloomy, nevertheless in certain types of growth and in certain regions, great advances have been made. In none have the advances been greater than in carcinoma of the cervix.

Those of us who were practicing gynecology at the beginning of this century will remember that at that time this diagnosis was tantamount to a sentence of death.

When I was the senior resident in my hospital, one of the house surgeons, for an M.D. thesis, investigated the after histories of a large number of these cases and he found that the early cases in which a vaginal hysterectomy had been performed had, on the average, a shorter life than the advanced cases which could be treated only by cauterization. No facts could be worse, but because of this carcinoma of the cervix was a hopeful field for experimentation.

At that time Wertheim was perfecting, performing, and popularizing the results of his operation. To the older men, trained in preantiseptic days, who had gained their position more as obstetricians than as gynecologists, many of whom were bewildered by the rapid surgical development which was growing around them, this operation was little better than human vivisection. They could not perform the operation and they did not think that anyone else could do so with justification.

This, and the fact that we have always to wait five years before we speak of results, accounts for the slow development of this operation, though eventually it was received by the younger school with enthusiasm and is still today one of the two recognized methods of treatment of this disease.

My old chief, Donald, did the first two Wertheim hysterectomies in Manchester; I assisted him and did the third one myself. We had not seen the operation performed and had to follow a translation of the written description; moreover, we had to discover for ourselves those technical difficulties which no description ever mentions. They were fearsome operations; mine took 2½ hours and I was very lucky to get the patient off the table alive, but she had complete freedom from recurrence for 5 years, when she reappeared with a small epithelioma in the vagina, its upper edge about half an inch from the vaginal scar, a condition more suggestive of a new-growth in a patient liable to cancer than a true recurrence.

In the meantime our technique improved and the operation time was reduced to one hour in favorable cases. Nevertheless, this operation is the limit of human endurance. I think every operator has to acknowledge a mortality of 20 per cent in his first hundred cases, though the rate steadily improves with experience; mine was rather above this level, but was below it in the second hundred, and in the last 20 cases I had only 1 death.

That is one side of the picture; the other, the hopeful side, is that for the first time we had a weapon which could cure the disease.

As we had to wait 5 years before we could speak of results, it took time for this operation to be popularized, if, indeed, this term could ever be applied to an operation which required so great an amount of technical skill, but Wertheim showed that instead of this disease being universally fatal, given reasonably early cases upon which he could operate, 40 per cent were alive and well at the end of 5 years. This,

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I think, is about the generally accepted figure from the best clinics, and we may take it as the best that can be done by this operation.

In Great Britain Berkeley and Bonney were among the first to perform and to perfect this operation and the latter is still its greatest exponent.

My own cases are rather less than half of those quoted by Bonney, but it is interesting to see how close are the results of two men working in different schools.

| | Victor Bonney | | Author | |
|---|---|---|---|---|
| | Cases | Per cent | Cases | Per cent |
| Died of operation..... | 55 | 14 | 33 | 21.4 |
| Lost sight of..... | 12 | | 9 | |
| Died from other diseases... | 12 | | 5 | |
| Recurrence within 5 years.. | 155 | | 48 | |
| Alive and well after 5 years. | 150 | 39 | 59 | 38.3 |
| | 384 | | 154 | |

Bonney thinks that 10 years' freedom from recurrence is a complete cure and his figure for this period is 20 per cent. It is difficult to know whether a second growth is really a new-growth in a patient with a liability to cancer or a recurrence from malignant cells lying dormant all this time. I cannot pretend to answer this question, but I have had a patient with a pelvic growth 12 years after I had performed a Wertheim's hysterectomy. My own cases after 10 years show freedom from recurrence in 27.5 per cent.

Berkeley and Bonney set a high standard in my country as Wertheim did in his, and it is one to which I hope we shall always adhere. When we speak of freedom from recurrence, we mean that these patients can be produced fit and well; those who have died of other diseases or are lost sight of are added to those who have died of the disease.

These figures are, I think, the best that can be hoped for from this operation—about 40 per cent free from recurrence after 5 years. These figures, however, apply only to those cases seen at a sufficiently early stage to allow of the completion of this operation. The percentage of these is very difficult to calculate as those hospitals which have made a feature of cancer treatment naturally attract a large number of hopelessly advanced cases. Bonney claims an operability rate of 63 per cent. My own operability rate I cannot calculate, as I was working in three institutions, in one of which the out-patient department and the beds were not under the same control, but my impression is that it was much less than 63 per cent.

The next great advance was the discovery that cancer of the cervix responded to radium. For more than a quarter of a century treatment by this means has been carried out and results have been published from many centers throughout Europe and in the United States. As might be expected, the results varied and still vary enormously. In the first place, the results improved as the methods of application improved, but even when these were more or less standardized, the results varied with the type of case treated.

In some centers the patients seek advice at an earlier stage of the disease than in others; in some the earliest cases are retained for operation and only the more advanced referred for radium treatment. It is also possible that there may be racial differences.

The chief difficulty in comparing results lay in the evaluation of the stage of the growth; was it operable or not? This was and is still a purely personal estimation and no two operators will agree upon a series of borderline cases. Heyman proved this in an amusing way at the British Congress of Obstetrics and Gynæcology held in Belfast in 1936. He put a series of diagrams on the screen and asked each member to enter on a form the stage of each diagram. He has since tabulated the results and the man who was 50 per cent correct was well up in the class. Many cases were entered in 3, and some even in 4, classes.

Naturally the radiologist tended to raise the line of demarcation and to put into the operability category a much smaller number than did the operator who attempted to perform the operation on every likely case. For a long time the controversy raged between operation and radiation, and as every disputant argued from different premises, it was very difficult, nay impossible, for any neutral observer to come to a definite decision.

Some 8 or 9 years ago one of my colleagues, Professor Daniel Dougal, and I—both keen performers of Wertheim's operation—felt that we must give serious consideration to the

alternative treatment by radium. It is difficult to believe and it is still more difficult to explain that at that time no figures were available from the large British radium centers, although these centers had used radium for this purpose for many years.

We were very much impressed by the results from foreign centers, but we could not abandon our operative treatment until we knew that the methods of administering radium in our country would give equally good results.

As the British radium centers did not, and still do not, give these statistics, there was no alternative but to purchase our own radium, treat our own cases, and carefully follow the results.

The first difficulty was to determine the method of application. It was only after careful thought and comparison of foreign results that we decided to follow the method used by Heyman in Stockholm, but with certain modifications suggested to us by Dr. Helen Chambers and Dr. S. Russ of the Middlesex Hospital.

After much delay we obtained 100 milligrams of radium element, made up in such a form that 40 milligrams could be inserted into the uterine cavity and 60 milligrams could be applied to the vaginal aspect of the cervix and vaginal fornices. The 40 milligrams were packed into 2 large platinum needles, with walls 1 millimeter in thickness and containing 24 and 16 milligrams, respectively; the 60 milligrams were packed into 15 small platinum needles, with walls 0.5 millimeter in thickness and each containing 4 milligrams of radium. To obtain the additional screenage necessary, the small needles were enclosed in three box applicators made of silver and with walls 1.6 millimeters in thickness.

We decided to apply the radium to the surface of the cervix rather than to insert the needles into the growth, since we found that there was a considerable mortality in certain institutions where the latter method was used, probably due to the inoculation of organisms into the subjacent healthy tissue. Each patient was treated on 3 occasions for 24 hours, there being an interval of 1 week between the first and second treatments and of 3 weeks between the second and third. The total dosage was therefore 7,200 milligram hours—larger than that now used by Heyman —, but we decided to adhere to this dose until we had some facts before us.

We obtained our radium in June, 1929, and up to January 1, 1931, we had treated 94 cases with these results:

| | |
|---|---|
| Dead or untraced | 55 |
| Alive and well after 5 years (41.4%) | 39 |

Included in the survivals is one patient who was well at the end of 5 years but who died of recurrence 18 months later. Another patient had a recurrence 4 years and 10 months after treatment and has been included in the fatalities, although she was alive at the end of the 5 year period.

### IMMEDIATE MORTALITY

One patient died from peritonitis after the second treatment and another from pulmonary embolism, so that the immediate mortality is 2.1 per cent—a very low figure compared with the mortality following the Wertheim operation.

The stages of growth into which these cases fall as estimated by Professor Dougal and myself are as follows:

| | Cases | Alive | Dead | Per cent |
|---|---|---|---|---|
| First stage | 11 | 7 | 4 | 63.6 |
| Second stage | 27 | 12 | 15 | 44.4 |
| Third stage | 40 | 17 | 23 | 42.5 |
| Fourth stage | 10 | 1 | 9 | 10 |

6 cases were unclassified.

There were 2 cases of cervical stump carcinoma following subtotal hysterectomy; both patients died from recurrence. It is somewhat unfair to include these, although we have done so, because it is impossible to insert the full dose of radium into the uterine cavity.

It will be noted that one patient with a fourth-stage carcinoma is alive and well after 5 years. When I first saw her I wrote to her doctor to say that the growth was advanced so far that no treatment held out the slightest chance of cure, but that from a psychological standpoint, to give her hope for a little time, I would treat her. She is alive and well today. Another patient in the same group was quite free from symptoms for 4 years but developed a recurrence during the fifth year.

These results provide a strong argument for the use of radium in apparently hopeless cases.

Two criticisms can be brought against these figures.

1. *Percentage of cases treated.* As we became more confident of our treatment, we gradually adopted our present method of treating every case of carcinoma of the cervix which presented itself to us. This, however, did not apply at first. We were carrying out an experiment, and in the early days we rejected some of the most advanced cases, while, on the other hand, we did not abandon the Wertheim operation and still performed it on the early cases. These figures, therefore, at first excluded the best and the worst cases. Gradually, however, we both abandoned the operation and by the end of 1930 we were treating every case by radium, irrespective of the stage of the growth.

2. *Microscopical confirmation.* At first this was not undertaken in the advanced cases; the diagnosis in these circumstances is so definite to an experienced clinician that such a confirmation appeared unnecessary. Later, when we realized that readers of our results would not have seen the cases and that acceptance of the diagnosis must rest upon our unconfirmed statement, we excised a piece of growth for laboratory confirmation as a routine measure. Microscopical examination, therefore, was performed in only about half of these cases, but those not so examined were so advanced that no error in diagnosis was possible.

These figures are small. It may be that with extended experience our results may not be so good, but I see no reason why they should not remain in the region of 40 per cent free from recurrence after 5 years.

The only considerable series of cases published in Great Britain from one center is that of the Marie Curie Hospital, London, which began its work 2 years before we began ours. Last year's report shows that of a total of 392 patients treated more than 5 years ago, 142, or 36.2 per cent, are alive and well.

It seems to us, therefore, from these figures that we are getting at least the same percentage of cure with the use of radium as with Wertheim's operation, but with this great difference—that the radium cases include advanced as well as early ones, while the operation list necessarily includes only those in the first 2 stages.

Even if the results with radium were just as good as, but no better than, those with the operation, radium would be the treatment of choice. There is such a slight mortality and, what is almost of more importance, the convalescence is painless, whereas after Wertheim's operation a large percentage of the patients are very ill for some days, and at the best are very slow in recovering from such a heavy strain.

Until increased knowledge puts some other treatment into our hands, can we do anything else to improve the weapons already in our possession?

In many centers deep x-ray therapy is used as a supplement to radium. In the series which I have reported, radium alone was used, but in one of our hospitals this combination has been used for some years, though it is too early yet to compare the results.

There is one striking fact in the cases with recurrence in that it usually takes place in the iliac glands; there is rarely a local recurrence in the cervix or vagina. This is what might be expected inasmuch as the effect of the radium diminishes with increasing rapidity in proportion to its distance from the object. If the glands are already invaded, they must receive a much lighter dose than does the cervix.

This would suggest the excision of the iliac glands after radiation of the cervix, as is done with growths in many parts of the body. So far we have not carried this out as a routine procedure, as it is a serious matter to suggest an abdominal section to a patient who has already had three anesthetics for the application of radium.

Many years ago, when radium was first brought to Manchester and long before we bought our own, I performed Wertheim's operation in 63 cases after preliminary treatment of the cervix with radium. After 5 years there were only 22 (34.9 per cent) alive and well, a result not so good as when the operation alone was performed.

In order to avoid the difficulties of scar tissue around the ureter I operated, on the

advice of the radiologist, a few days after the application of the radium—and I do not know what dose of radium was given.

The figures which I have quoted as the results of operative and radium treatment are not unique. The same results can be and are being obtained elsewhere. The value of these figures lies in the fact that they are from one clinic and, therefore, being free from personal bias, allow of comparison between the 2 methods of treatment. After careful observation of these cases for over 7 years, Professor Dougal and I have come to the definite conclusion that radium offers the best chance of cure as well as being the more humane method of treatment. Therefore, strong advocates though we were of the operation, we have now abandoned it.

These figures, however, do not warrant any complacency. A record of 40 per cent alive and well at the end of 5 years allows of hope but no self-satisfaction. Eventually the cause will be found and prevention or cure will follow, but until that object is achieved, we must use as best we can the imperfect weapons put into our hands.

## Discussion

DR. FLOYD E. KEENE, Philadelphia: This presentation by one of England's most distinguished gynecologists contains a message of greater import than the recital of a personal experience in the treatment of cancer of the cervix; it exemplifies the state of mind which must prevail in our efforts to combat the disease. Irrespective of the method employed, and under the most favorable circumstances as regards technical skill and equipment, not more than 25 per cent of the patients can be saved. With such deplorable results, it is evident that the treatment of cervical cancer is not a closed book, but an issue requiring a receptive mind, willing to give serious consideration to any procedure which is based upon sound scientific principles.

I am in full accord with Dr. Shaw's conclusions regarding the comparative value of the Wertheim operation and irradiation. My experience dates back 30 years to the early days of my apprenticeship with Dr. John G. Clark, when radical operation was at the height of its popularity. Its technical difficulties, high mortality and morbidity, and disheartening end-results remain a vivid memory. Radium was introduced into our clinic by Dr. Clark in 1913. For a time its use was limited to the advanced lesions, but as evidence of its value increased, its sphere was gradually widened until finally operation was discarded in its favor. A hysterectomy for cervical cancer has not been performed in our clinic in the past 15 years.

During these 20 odd years, our methods of application, dosage, and filtration have been modified from time to time. For the past 4 years, the dosage has ranged between 4,800 and 6,000 milligram hours with a filtration of 1 millimeter of platinum and 2 millimeters of rubber for the intra-uterine radium and 2 millimeters of platinum with 1 centimeter of rubber in the form of the colpostat or capsules for the application to the vaginal fornices and cervix. Roentgen therapy has supplemented the radium in all cases with the exception of those with stage IV lesions; in these, roentgen therapy alone is used, with radium application later when indicated. Repetition of the treatment is not carried out at regular intervals, but only when conditions which warrant it arise. Experience has taught us that the ultimate result is dependent upon what has been accomplished by the initial treatment; if this fails, not much can be expected from subsequent applications.

Dr. Shaw's total salvage of 40 per cent and his 50 per cent 5 year salvage of the operable cases are superior to ours, which are approximately 18 and 35 per cent, respectively. In part, at least, this difference is due to the fact that many of our patients have been traced 10 years or more. Freedom from recurrence for 5 years after treatment is by no means a guarantee of cure; results based upon 10 years' observation will yield a more accurate appraisal of what has been accomplished.

In none of Dr. Shaw's patients has high-voltage roentgen therapy supplemented radium. Impressed by the arguments advanced in its favor and encouraged by the results reported, I adopted it 4 years ago as a routine procedure. At first a skeptic, I am now convinced of its palliative value as attested by diminution or healing of the local lesion, lessening of the parametrial fixation, relief of pain, and improvement in the patient's general condition. In most instances, this respite is but temporary, and my observation has been that when this interval of improvement terminates, further roentgen therapy will be of little or no avail.

Sufficient time has not elapsed to evaluate the *curative* effects of roentgen therapy. My experience as well as that of others indicates that in the lesions limited to the cervix and adjacent tissues, it is a valuable adjunct to radium in that it reaches the disease beyond the 3 to 5 centimeters of radium influence. There is reason to hope, therefore, that the combination of radium and roentgen therapy will increase the incidence of cures in the earlier lesions. On the other hand, in that large group with metastases to glands and other structures, the roentgen therapy of today offers little or no hope of increasing

the salvage. This form of therapy is in its infancy, and with fuller understanding of its activity, and improvements in technique and equipment, it gives promise of being the medium by which advance in the treatment of cervical cancer will be achieved.

DR. BROOKE M. ANSPACH, Philadelphia: Dr. Shaw has made a valuable contribution. Here we have a man who has practiced both the operative and the radiation plan of treatment for carcinoma of the cervix. He has had as much success as anyone with the Wertheim operation and yet, after an equal experience and an equal success with radiation, he prefers the latter.

Those who have seen a Wertheim operation performed by Bonney can understand his enthusiasm in advocating the radical operation. It seems to be such an efficient and thorough way of ridding the patient of her disease at one stroke.

Yet the experience and skill required to perform the operation fall to few men. The apprenticeship is long and difficult and beset with disaster. And after viewing such a hysterectomy, performed even with the utmost skill and thoroughness, one is tormented with the question, Can it all be removed? Are there not cancer cells remaining in this area or in that—cancer cells that were there before the operation was begun or cancer cells that have been squeezed through the lymph spaces during the operation?

Whatever our arguments may be, the outstanding fact is that Dr. Shaw has had equally good results with radiation and that with a mortality and a morbidity so much reduced in comparison with the operation that his conclusion must follow as a matter of course.

In the radiation treatment of carcinoma of the cervix there are many problems for consideration. So far as the results are concerned, it would be of great advantage to adopt a uniform method in reporting them; otherwise there is not a sound basis of comparison between the statistics of one clinic and another.

Our chief interest at the Jefferson Hospital just now lies in the technique of radiation. We cannot help but believe that radiation from without should be combined with radiation from within as a matter of routine.

On theoretical grounds at least, it would appear that if the entire cancer area and its environs are radiated before there is any mechanical disturbance of the cancer, we shall be more certain to expose every cancer cell to the $\gamma$-rays as well as to avoid any dissemination of the growth.

The internal radiation should be started at the height of the external radiation before those changes in the connective tissues have occurred that make internal radiation more difficult and less effective.

Experience may show that radiation from within, that is, the placing of radium element in the carcinomatous area with a minimum of mechanical disturbance, should come first.

The absolute percentage of 5 year salvage in this country reported by various observers is about 20. In the earlier cases, of course, the percentage is much higher. Our figures in this country compare favorably with those of Heyman in the Radium Hemmet at Stockholm.

In view of the amount of radium at his disposal and the admirable technique which he is thus enabled to adopt, one is surprised that our figures here seem to be almost as good. It might appear, therefore, that the influence of the $\gamma$-rays is the crux of the situation and that, in spite of differences in the technique of application, the results are more or less the same.

But again on theoretical grounds, perhaps on the grounds of plain common sense, we would have to expect better final results, when a large amount of radium is available, when careful screening is a matter of routine, and when the patient at the very first and all through her subsequent life is given the advantage of periodic examinations and an accurate record of the findings.

Of the greatest importance is the early recognition of the growth. Early cases properly radiated yield a high percentage of cure.

# MORE CONSERVATISM IN CESAREAN SECTION

FRANK W. LYNCH, M.D., F.A.C.S., San Francisco, California

THE high death rate attending pregnancy[1] in the United States is again exciting much discussion; first because it has remained almost stationary for many years while the mortality attending major surgical procedures has been steadily declining; and second because the maternal mortality rate in the United States continues to exceed that of nearly every other important country (Fig. 1). The earlier attempts to focus national attention upon this question failed largely because of the insistence of those who claimed that our rate was fictitiously high because there was no uniform method of interpreting maternal mortality data in various countries. More recently, however, a committee headed by Elizabeth Tandy, director of the Statistical Division of the Children's Bureau, created by the White House Conference to compare the maternal mortality rates of various countries dispels this view by its report (in 1935). It stated that "differences in method of assignment of death causes (when there are multiple or joint causes of death) are insufficient to explain the high maternal mortality of the U. S. as compared with foreign countries," and that maternal mortality "rates for the U. S. estimated in accordance with the assignment procedure of the respective countries are in all instances except Scotland in excess of and in five instances more than double the official rate of the countries themselves."

A series of recent studies represent America's first serious attempts on an adequate scale to discover the reasons for and to control its high maternal mortality rate. A review of the maternal deaths recorded during 1927 and 1928 in 15 states in the birth registration areas, made by the United States Children's Bureau, has been followed by other similar compilations for cities, among which we may cite those of New York for 1930, 1931, and 1932; Philadelphia for 1931, 1932, and 1933; San Francisco and the Bay Cities for 1932 to 1935 inclusive; and the 7 large cities of the Pacific Coast for 1933 and 1934.

The observations in these mortality studies concerning cesarean section attract our attention because this operation recently has become a very common instead of a most uncommon method of operative delivery, and because more than one-half of the deaths following cesarean section have occurred in women who previously had borne children through the normal birth passages. Moreover, the incidence of cesarean section in mortality studies cited above has risen from 11 per cent in 1927 to 33 per cent in 1934. Thus we find that cesarean section preceded 11 per cent of all puerperal deaths in or after the seventh month of pregnancy in the 15 states' report for 1927 and 1928. For New York City, 1930 to 1932 inclusive, the figures were 19.8 per cent; for Philadelphia (1931 to 1933 inclusive) 23 per cent; for San Francisco and the Bay Cities (1932 to 1935 inclusive) 31 per cent; and for the 7 Pacific Coast Cities (1933, 1934) 33 per cent. It was the method of delivery in 2.2 per cent of all births in New York City in 1930 to 1932, of 2.58 per cent of all hospital deliveries there, and in 1.78 per cent of all the births in the entire city of Philadelphia for the 3 years 1931 to 1933 inclusive. It was utilized for more than 3 per cent of all births during 1933 and 1934 in Los Angeles County (Thompson) and for 5.5 per cent of all hospital births in San Francisco, Berkeley, and Oakland in the period from 1932 to 1935 inclusive. In 1934 there were 6 states in which at least 1.3 per cent of all deliveries were by cesarean section: in Massachusetts, there was 2.05 per cent; in California 2 per cent; in Connecticut 1.53 per cent; in New York and Wisconsin each 1.34 per cent; in Maine 1.3 per cent. In fact, 0.76 per cent of all women delivered in the United States in 1934 were by cesarean section, as were 2.8 per cent of all the hospital births.

Presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

[1] Mortality rates obtained from U. S. Census, U. S. Dept. of Labor, Children's Bureau, Washington, D. C. Incidence of cesarean section, percentage of deliveries in hospitals, and hospital mortality rates obtained from the American College of Surgeons.

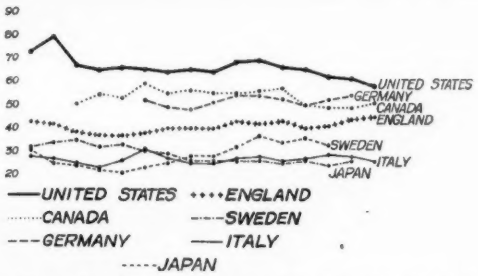


Fig. 1. Trend of maternal mortality in the United States and certain foreign countries; deaths assigned to pregnancy and childbirth per 100,000 live births.

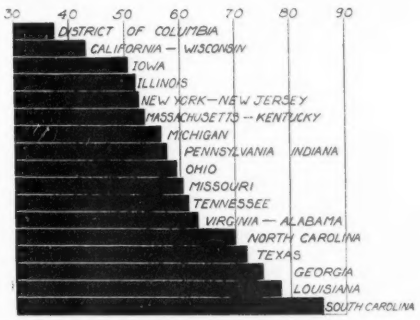


**Fig. 2. Maternal mortality in United States, 1934. Rate per 1000 live births. Includes all States with more than 50,000 births except District of Columbia, 10,137; South Carolina, 44,625.**

This tremendously increased incidence of cesarean section should have done something to reduce the United States maternal mortality rate if the indications for the operation were sound and the mortality rate was properly low. The national maternal mortality rate, however, has remained practically unchanged for many years. Nor do graphs of maternal and fetal mortality by states and by their urban and rural communities show reductions which can be credited to this operation alone. The states with the lowest maternal mortality are not uniformly those which have the highest incidence of cesarean section, nor do the states with the highest incidence of cesarean section uniformly have the lowest mortality rate during the last 5 years. This can be seen by study of the tables. Yet we should expect such results if the operation now saved lives that would have been lost during other methods of delivery formerly employed and now largely abandoned (Tables I, II, III, IV, and V).

This tremendous increase in cesarean section has been initiated both by the laity and profession—the laity because of desire to

TABLE I.—STATES WITH LOWEST MATERNAL MORTALITY AND THEIR INCIDENCE OF CESAREAN SECTION

| State—1934 | Maternal mortality per cent | Incidence of cesarean section per cent | Deliveries in hospital per cent |
|---|---|---|---|
| District of Columbia | .38 | .98 | 57.0 |
| Vermont | .39 | 1.15 | 27.9 |
| California | .43 | 2.00 | 39.2 |
| Wisconsin | .43 | 1.34 | 27.2 |
| Minnesota | .45 | .42 | 28.9 |
| Utah | .45 | .34 | 29.3 |
| Connecticut | .47 | 1.53 | 59.2 |
| North Dakota | .47 | .22 | 17.5 |
| Washington | .49 | .89 | 35.2 |
| South Dakota | .51 | .31 | 12.2 |
| Iowa | .51 | .64 | 19.5 |
| Nebraska | .52 | .96 | 18.4 |
| Illinois | .52 | .97 | 50.5 |
| New York | .53 | 1.34 | 57.2 |
| Massachusetts | .54 | 2.05 | 50.3 |
| Michigan | .57 | .62 | 26.6 |
| Pennsylvania | .58 | 1.01 | 36.7 |
| Indiana | .58 | .79 | 17.5 |

TABLE II.—STATES WITH HIGHEST INCIDENCE OF CESAREAN SECTION AND THEIR MATERNAL MORTALITY, EXCLUSIVE OF SOUTHERN STATES

| State—1934 | Incidence of cesarean section per cent | Maternal mortality per cent | Deliveries in hospital per cent |
|---|---|---|---|
| Massachusetts | 2.05 | .54 | 50.3 |
| California | 2.00 | .43 | 39.2 |
| Connecticut | 1.53 | .47 | 59.2 |
| New York | 1.34 | .53 | 57.2 |
| Wisconsin | 1.34 | .43 | 27.2 |
| Maine | 1.30 | .60 | 14.5 |
| New Hampshire | 1.18 | .57 | 31.1 |
| Vermont | 1.15 | .39 | 27.9 |
| Pennsylvania | 1.01 | .58 | 36.7 |
| New Jersey | 1.01 | .53 | 46.9 |

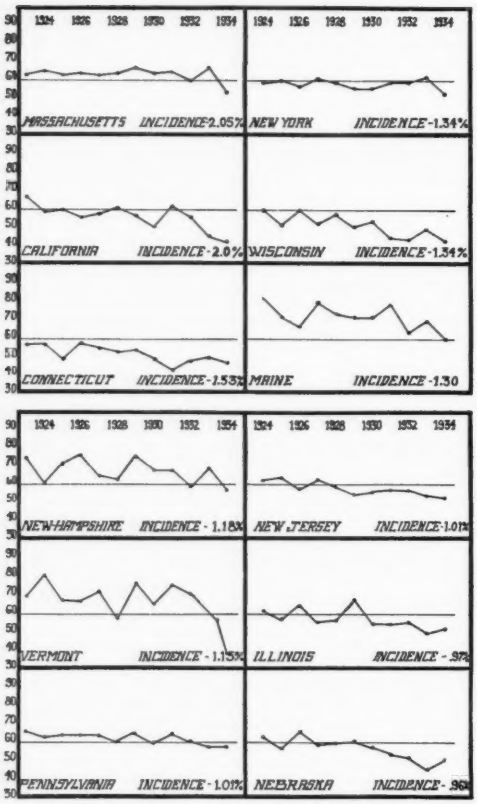


Fig. 3. Maternal mortality of states with highest incidence of cesarean section.

escape the pain and terror of labor which they have been taught to believe is an unnecessary and unmodern thing—the profession because it feels that improvements in surgical technique must have made safe an operation the surgical mortality of which could have been considerable only in almost antediluvian time. Consequently, physicians with neither special training in obstetrics or in general surgery undertake cesarean section without full consciousness of the threat that their surgery entails. They choose the classical cesarean because it seems simplest to perform. Yet the classical cesarean section is and always must be one of the most illogical of surgical procedures—one which infection can readily break down. No other operation is

TABLE III.—STATES WITH LOWEST INCIDENCE OF CESAREAN SECTION AND THEIR MATERNAL MORTALITY, EXCLUSIVE OF SOUTHERN STATES

| State—1934 | Incidence of cesarean section per cent | Maternal mortality per cent | Deliveries in hospital per cent |
|---|---|---|---|
| North Dakota | .22 | .47 | 17.5 |
| Utah | .34 | .45 | 29.3 |
| Missouri | .39 | .61 | 29.6 |
| Minnesota | .42 | .45 | 28.8 |
| Michigan | .62 | .57 | 26.6 |
| Iowa | .64 | .51 | 19.5 |
| Ohio | .77 | .60 | 29.9 |
| Indiana | .79 | .58 | 17.5 |
| Washington | .89 | .49 | 35.2 |
| Oregon | .95 | .61 | 35.2 |

uniformly attended by as much blood loss, by as frequent postoperative shock, or by as dense abdominal adhesions; in no other operation do the incised uterine muscles begin involution even while the surgeon is sewing the incision. Failures in healing, therefore, are easy to understand. The blood vessels in the uterine wall are controllable in classical cesarean section only by mass ligation; only in this way can one obtain a dry wound. Yet none of us would expect to obtain a firm scar in the abdominal wall if its muscles began involution

TABLE IV.—STATES HAVING HIGHEST PERCENTAGE OF HOSPITAL DELIVERIES WITH THEIR INCIDENCE OF CESAREAN SECTION AND MATERNAL MORTALITY, EXCLUSIVE OF SOUTHERN STATES

| State—1934 | Births in hospitals | Incidence of cesarean section | Maternal mortality |
|---|---|---|---|
| Connecticut | 59.2 | 1.53 | .47 |
| New York | 57.2 | 1.34 | .53 |
| District of Columbia | 57.0 | .98 | .38 |
| Rhode Island | 51.7 | 1.16 | .55 |
| Illinois | 50.5 | .97 | .52 |
| Massachusetts | 50.3 | 2.05 | .54 |
| New Jersey | 46.9 | 1.01 | .53 |
| California | 39.2 | 2.00 | .43 |
| Pennsylvania | 37.7 | 1.01 | .58 |
| Oregon | 35.2 | .95 | .61 |

during the operation, and if the surgeon were forced almost to strangulate the degenerating muscle before all bleeding was controlled. Firm peritonization of the uterine wall is impossible in the classical operation. There are fewer objections to the low segment type cesarean because the uterine contractions about the incision are less severe, the involution is less marked in the region incised, and peritonization can be obtained by the bladder flap. Yet it appears as if this operation was almost unknown or not acceptable to the majority of physicians who are performing cesarean section because from 60 to 80 per cent of all cesarean sections in the mortality studies were of the classical type. Moreover, conservative classical cesarean section was performed innumerable times upon patients and reviewed in the mortality studies who had potential or actual infection as attested by many vaginal examinations prior to delivery and even after ineffectual attempts to deliver vaginally. The radical or modified Porro operation was rarely used in spite of the fact that the contra-indications to the classical cesarean section in such cases has been established for nearly 30 years, and the classical work of Frank, of Routh, and of Holland permits no controversy.

Long before Saenger and now many years after, the classical cesarean operation has been one of the most hazardous procedures in common use. Yet at least yearly for nearly 40 years, some advocate of this operation brings forth his claim that when the case is well selected for operation, the mortality should be as low as in any other elective surgery. That well may be, but it has never been demonstrated as a fact in any series of at least 500 clinic cases. On the other hand, the surgical mortality is becoming less and less in other gynecological surgery with improvements in technique and better selection and preparation of cases. There are many surgeons listed in our membership who have performed more than 500 hysterectomies for fibroids with considerably less than .8 per cent of surgical operative mortality. The low or cervical type cesarean section promises better things, yet only Adair's clinic in the University of Chicago has a truly low surgical mortality in a series so

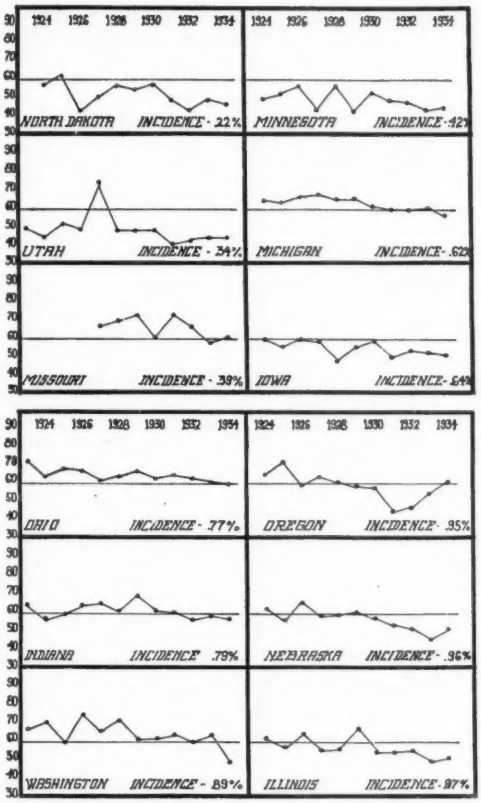
NORTH DAKOTA INCIDENCE - 22%
MINNESOTA INCIDENCE - 42%
UTAH INCIDENCE - 34%
MICHIGAN INCIDENCE - .62%
MISSOURI INCIDENCE - 38%
IOWA INCIDENCE - .64%
OHIO INCIDENCE - .77%
OREGON INCIDENCE - .95%
INDIANA INCIDENCE - .78%
NEBRASKA INCIDENCE - .96%
WASHINGTON INCIDENCE - .89%
ILLINOIS INCIDENCE - .97%

Fig. 4. Maternal mortality of states with lowest incidence of cesarean section.

large that the low death rate could not be unduly distorted by a comparatively few deaths occurring in the next 50 or 100 operative cases. His series stands alone with 1 per cent uncorrected surgical mortality and 500 consecutive low cesarean sections. Some fairly large series of cesarean sections in private cases also have low surgical mortality rates, yet serious emergencies and patients who elsewhere have had ineffectual attempts at delivery are far less common in private than in clinic series. The obstetrician who compiles a large series of his clinic and private cases is most likely to find that the surgical mortality in his clinic cases is disagreeably high.

The mortality attending cesarean section before 1930 has been cited in numerous studies

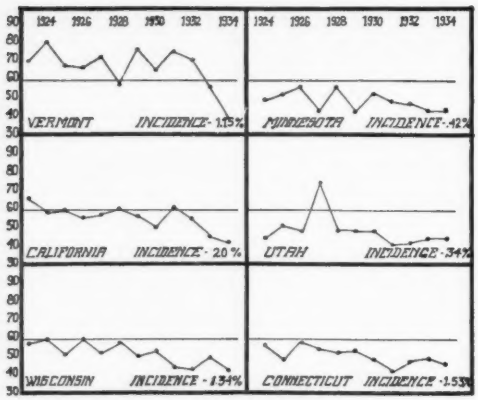


Fig. 5. States with lowest maternal mortality and their incidence of cesarean section.

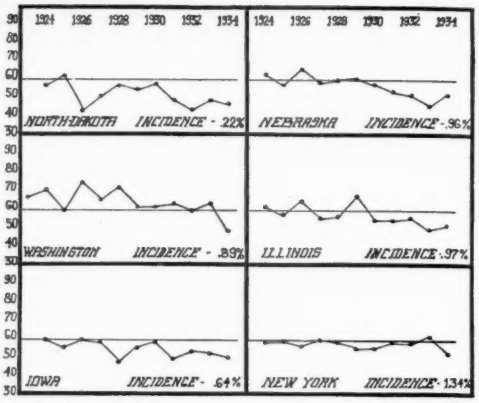


Fig. 6. States with lowest maternal mortality and their incidence of cesarean section.

and needs no review. For him who believes that the operative mortality must be lower now than formerly, I have collected the essential facts of the larger series reported in the literature of the last few years and operated upon since 1930. To these I add the following studies reported this year: Thompson's figures dealing with cesarean section in Los Angeles County; Bell's figures on the incidence and the mortality of cesarean section in San Francisco, Oakland, and Berkeley; and the report of Calkins, Mengert, et al. reviewing 559 cesarean sections performed by 132 members of the Central Association of Obstetricians and Gynecologists. In the total series collected, there were 524,117 women delivered, and of these deliveries 12,955 were by cesarean section. In this series, the incidence of the operation was 2.5 per cent and the surgical mortality was 4.1 per cent. There is small but unavoidable error in this compilation because of a small percentage of duplication of cases in the Chicago statistics, and because more than one-half of the cases are computed in terms of delivery rather than of live birth (Table V).

The various operative mortality rates in Table V as a group are very high. Four range between 0.7 and 2.5 per cent; 7 are between 3.3 and 7 per cent. Their meaning, however, can best be expressed in terms of the mortality rate of the cesarean section in relation to all deliveries in the series irrespective of method. When the figures are so expressed, it becomes evident that, though 7 per cent of the 900 women in Iowa who were delivered by cesarean section died, nevertheless the mortality rate of cesarean section in relation to the entire 91,738 deliveries was only 0.07 per cent. One may also see that the cesarean operation created a general mortality rate of only 0.07 per cent for the 61,513 women who bore children in 1934 and 1935 in Los Angeles County, and rose gradually in other places to attain the high point of a mortality from the operation of 0.14 per cent for the 68,733 parturients in Philadelphia. This is in spite of the wide variations in the percentage of deaths following the cesarean operation: 7 per cent in Iowa, 2.5 per cent in Los Angeles, and 5.5 per cent in Philadelphia. The series from Akron, Margaret Hague Maternity, and the most excellent report of Stander cannot be considered as individual units in this review because they present too few cases for statistical purposes. They clearly indicate, however, trends of cesarean section in their various hospitals.

Table V shows that the deaths following cesarean section created a maternal mortality rate of 0.1 per cent (10 deaths per 10,000) in the 524,117 women of the series studied. The figures assume added meaning when we recall that the maternal death rate of the United States is .6 per cent (60 deaths per 10,000), and is composed of rates of 20 per 10,000 for

TABLE V

| Cesarean section—1930–1935 | Births | Cesarean sections | Incidence cesarean per cent | Operative mortality of cesarean per cent | Maternal mortality of C.S. in terms of total deliveries per cent |
|---|---|---|---|---|---|
| State | | | | | |
| Iowa—1930–1932 | 91,738 | 900 | .98 | 7.0 | .07 |
| County | | | | | |
| Los Angeles—1934–1935 | 61,512 | 1702 | 3.0 | 2.5 | .07 |
| Cities | | | | | |
| New York—1930–1932 | 181,097 | 3963 | 2.19 | 6.1 | .13 |
| Philadelphia—1931–1933 | 68,733 | 1775 | 2.6 | 5.5 | .14 |
| Chicago—1934 | 33,338 | 951 | 3.1 | 3.7 | .11 |
| San Francisco Bay Cities—1932–1935 | 37,303 | 2118 | 5.7 | 1.7 | .10 |
| Akron—three hospitals—1930–1933 | 6,533 | 157 | 2.4 | 4.4 | .11 |
| Central Association—132 members—1935 | 12,061 | 550 | 4.6 | 3.3 | .15 |
| University of Chicago—1931–1934 | 17,493 | 500 | 2.8 | 1.0 | .03 |
| Margaret Hague Hosp., N. Y.—1931–1933 | 8,852 | 177 | 2.0 | 3.99 | .08 |
| Women's Clinic of N. Y.—1932–1934 | 5,456 | 153 | 2.8 | 0.7 | .02 |
| Totals | 524,117 | 12,955 | 2.5 | 4.1 | 0.10 |

the dead under 7 months' uterogestation, and for 40 per 10,000 for those in the last trimester. So we see that in the United States the deaths following cesarean section constitute approximately one-fourth of the maternal deaths from all causes after the seventh month of pregnancy. The death rate from cesarean section (0.1 per cent) in this series of 524,117 deliveries is one-third of the maternal death rate from all causes and from all periods of pregnancy for the countries of Sweden, of Norway, of Italy, or of Japan.

It would seem that an operation that carried a surgical mortality rate of 4 per cent would never be performed except for the most compelling indications. The literature does not support this view, probably because most physicians feel that they can do their surgery with less than the average surgical mortality rate. Separate and distinct from the many cases in which the indications are compelling and the operation is truly life saving, I find an ever growing list of cesarean sections performed for no obstetrical indication. Thus, I find reported cases "on demand of the patient," "wish of the family doctor," "economic reasons," "to preserve a normal pelvic outlet," "a recent vaginal repair," "repeated attacks of false labor," "fetal distress," "premature rupture of the membranes without labor pains although the pelvis is not contracted or abnormal," "no indication," the physician's own statement in responding to a questionnaire, as well as many patients in whom the desire for sterilization entered prominently into the indications. We are all offenders on this last count and the list is growing daily. Yet when sterilization is indicated it may be produced more safely on another occasion as Arnot, who reviewed my own cases so ably, has so clearly shown. Thompson reports 2 deaths in the 72 cases in which the operation merely offered opportunity to "cut the tubes." Other reports show high operative mortality rates in cases in which the indication for the operation was at least debatable. Multiple operations must add danger to cesarean section, just as they do to all other major surgical operations.

All physicians do not see the case the same way as is evidenced in a recent report. Two groups, each of 13 physicians, delivered approximately the same number of private patients in 1935. The first group stated in their replies to the questionnaire that they found cesarean section necessary twice only in 1,229 deliveries. The other group, members of the same special medical society, performed 166 cesarean sections in 1,229 cases. The reasons for operation may have been more compelling in second group. At any rate, there were 9 deaths among the 166 cases; an operative mortality rate of 4.8 per cent in spite of the fact that the incidence of cesarean section was 14.1 per cent.

## CONCLUSIONS

1. The maternal mortality of the United States is unduly high.

2. The incidence of cesarean section is rapidly increasing, yet has not lowered the maternal mortality in the United States.

3. The classical cesarean section is performed far too frequently by untrained surgeons, and by trained surgeons in the face of indications which experience has shown entails unjustifiably high maternal and fetal mortality. The low cesarean section cannot safeguard parturient women when there are contra-indications to the performance of a conservative cesarean section.

4. Careful consideration should be given to the indications for and the contra-indications of this operation and the best method of performing it. Its application should be limited to those cases in which valid reasons for its use exist.

5. To achieve such consideration and consequent limitation, the American College of Surgeons should restate indications for cesarean section valid at the present time, and instruct hospitals certified by its Board to permit the operation only after consultation with one of the chief obstetricians of its senior staff. Only by such means can the profession safeguard an operation which is at present a very dangerous procedure.

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## Discussion

Dr. P. Brooke Bland, Philadelphia: Of all the major obstetric operations, cesarean section is infinitely the most grave. If it were generally realized that the operation is the most serious surgical procedure performed within the abdominopelvic cavity, there probably would be no occasion to plead for "more conservatism."

The maternal morbidity and mortality rate in this country, as well as throughout the world, following cesarean delivery, exceeds any other major operation performed intra-abdominally. If this truth, too, were generally known, we believe that it would serve as a deterrent to the promiscuous resort to the procedure.

Only with the turn of the century did articles appear in the literature advocating a conservative policy. The alarmingly high operative mortality of cesarean section certainly must be common knowledge, but it is not widely appreciated.

In an exhaustive analysis of the world's literature for the past two decades I found a series of 65 papers devoted to a general survey of postoperative cesarean section mortality.

In this series there were recorded 1,843,356 deliveries. Of this number 19,480 (1.5 per cent) were effected by the abdominal route and 1,269 (6.5 per cent) of the patients died. In some of the papers published in this country, the maternal death rate

recorded was unbelievably high. For example, in the series reported by Bickel, of Indiana, it was 17.3 per cent. In the survey conducted in the city of New Orleans it was 16.1 per cent. Magnus Tate, of Cincinnati, Ohio, in his study reported a maternal mortality of 16 per cent. In a survey made in the state of Texas, it was 14.4 per cent.

In Europe the rate runs a deadly parallel and ranges between 6 and 7 per cent.

Moreover, it is incumbent to recollect that the operation is not only designed as a life saving measure for the mother, but the fetus as well. Since failure occurs with regard to the former, it is logical to assume that the baby sometimes succumbs. The loss of fetal life is by no means negligible. In the series of 1,843,356 deliveries with 19,480 sections recorded in this country and abroad there were 913 dead babies or a fetal mortality of 4.4 per cent. This feature, too, cannot be disregarded. It must be taken seriously into account in pointing out the hazards in all appeals for a more conservative approach to the operation.

Since not all cesarean sections are surgical emergencies, it cannot be successfully argued that the high maternal death rate is the result of an emergency measure. The electively performed or so called "clean" operation is by no means void of danger and takes its toll.

The chief factor, I think, conspiring to thwart a conservative attitude regarding the operation is its apparent technical simplicity and for the unwary herein lies a grave delusion and snare.

This misconception has not only led to its unduly frequent and unwarranted performance, but to its performance by those who are unable to apprehend its true indications and are inept in its technique.

For example, in a survey conducted by the committee on public health relations of the New York Academy of Medicine, in New York City, it was astounding to learn that patients were attended in pregnancy and labor, spontaneous and operative, not only by obstetricians and general surgeons, but also by almost every type of specialist known, including pediatricians, otolaryngologists, dermatologists, radiologists, ophthalmologists, pathologists, anesthetists, orthopedists, urologists, gastro-enterologists, neurologists, and psychiatrists.

Almost precisely similar observations were made by the committee on maternal welfare in a survey made in Philadelphia. In the Quaker City it is pertinent to mention that to the long list enumerated, the osteopath contributed his part. Certainly with regimentation of this sort a favorable concurrence of circumstances, so far as the patient is concerned, is wholly impossible.

From the foregoing, one may safely assert that there are too many obstetricians doing obstetric surgery who are not surgeons. Similarly there are too many surgeons doing obstetric surgery who are not obstetricians, and further, there are far too many *men and women* doing obstetric surgery who are neither obstetricians nor surgeons.

There are, besides, many other factors accountable for the undue frequency of the operation, as well as the high mortality it carries. In the whole realm of surgery there is no major operation less difficult to perform. Moreover, it is the most enchanting and spectacular of all major surgical procedures. It thus appeals irresistibly to the man with a flair for showmanship, the surgical exhibitionist, as well as those falling in the "bootleg" group and loosely inclined ethically. Besides there seem to be in this country far too many "insatiables," and a dearth of group A surgeons who really know when not to operate.

I heartily agree with Dr. Lynch in his plea for more conservatism in cesarean section. It is sorely needed, for not only are too many cesarean operations being performed, but still worse, the surveys conducted in this country and elsewhere show conclusively that far too many obstetricians, so called, are doing abdominal surgery who are not trained in surgical art. This feature has led to a great deal of chaos all along the line.

While no one will gainsay the importance of advocating a more conservative attitude with respect to cesarean section, it is, at the same time, most essential, I think, to plead for a more conservative, as well as a more rational, attitude in obstetric practice in general.

DR. EDWARD A. SCHUMANN, Philadelphia: The well considered and thoughtful paper of Dr. Lynch admits of no adverse criticism. One must agree with all his premises and I can only urge the widespread acceptance of his conclusions by the physicians of this country.

The tenuous indications upon which this major operation is often performed are little short of appalling, although one fact may be offered in extenuation. Abdominal surgery has become so safe and is invoked so generally for comparatively slight lesions that the peril in connection therewith is largely discounted by the profession.

The low mortality of appendectomy, cholecystectomy, and gastric enterostomy has produced a surgical state of mind among physicians generally, and as a result cesarean section is utilized much more freely than formerly.

It is also true that there remain many obstetricians, highly experienced and competent in vaginal delivery, whose surgical equipment is entirely lacking, and who limit their abdominal operative work to the occasional cesarean sections arising in their practice. Men who would not attempt a hysterectomy for fibroid or the simple removal of a ruptured tubal pregnancy will unhesitatingly perform abdominal hysterotomy.

In evaluating the statistics of cesarean section, I am continually impressed with the necessity for dividing the cases into elective section and those of necessity, performed after vaginal delivery has proved impracticable. Practically all of the published figures are based upon the total number of operations, without regard for the time of their performance or the state of the patient at that time.

To group together, for mortality statistics, the cases of purely elective section done for moderate disproportion, before the onset of labor, without vaginal contamination and under local anesthetic, with cases of the same operation performed after vain attempts at forceps delivery, in the terminal phase of eclampsia, on women exsanguinated from abruptio placentæ, is not only futile but foolish.

The purely elective section is one of the safest abdominal operations and should not be attended by mortality higher than that which occurs in invasion of the peritoneal cavity for any purpose. This type of section in the hands of trained men may properly be performed not only as a life saving measure, but to avoid vaginal delivery which may prove mutilating to the mother and perilous to the baby because of disproportion or, indeed, certain types of malpresentation. On the other hand, the too late hysterotomy, and even the presumably elective operation, done when the moment of election has passed and by men untrained in the niceties of gynecological surgery, spells disaster.

In evidence of my strong support of Dr. Lynch's views an analysis of my own clinic is presented.

The Kensington Hospital for Women is a small institution, serving its district in that no obstetrical patient is refused admission, whether registered or not and regardless of her condition. During the past 5 years there have been 4,683 deliveries in this hospital with 58, or 1.23 per cent, cesarean section for all causes. This includes cases of ruptured uterus sent in from the outside, decompensated cardiacs, and obstructed labor of all types as well as the selected cases from our own prenatal service. The gross mortality was 3.45 per cent and it is an interesting commentary that in neither of the two women who died could the section be ascribed as even contributing to the fatal termination.

One case was that of a patient with abruptio placentæ who had total suppression of urine before operation and who died of uremia on the second day after a section under local anesthesia. The second case was that of a woman exsanguinated from placenta praevia centralis hemorrhage, in whom the cervix was long and canalized and undilated. This woman would have lost her life by any method of delivery, and the rapid section under local anesthesia, after a blood transfusion, certainly did not lessen her chances for recovery.

All the other patients in this series recovered, so that one may fairly say that cesarean section or its consequences was not responsible for a single fatality in 5 years.

To summarize my own views upon this most important subject:

1. The elective section under local anesthesia, done by one well skilled in abdominal surgery, carries with it a negligible mortality and morbidity and offers a better end-result for mother and child than does a traumatic vaginal delivery, in untrained or even competent hands. The corollary to this observation is that patients should be carefully studied prenatally and when disproportion exists, the woman should be referred to a trained man for his opinion, which should be confirmed by roentgenological pelvimetry before the onset of labor, and that if section is determined upon, it should be performed by some competent person.

2. In cases of potential or actual infection some one of the extraperitoneal operations should be practiced invariably.

The attention of the profession should be sharply called to the laxity now prevalent in deciding upon the indications for this formidable procedure, and to the lack of adequate training of many of its proponents. In this connection it may be said that the American Board of Obstetrics and Gynecology is working whole heartedly toward the better training and more complete specialization of practitioners of the art of obstetrics.

# THE ESSENTIAL FEATURES IN FRACTURES OF THE SHOULDER

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THE time is not long past when the treatment of almost any type of fracture was considered to be within the province of the medical practitioner, but with the advent of this highly industrialized era, fractures have taken on a new interest. Indeed, so important have they become that in most modern hospitals these cases are segregated and taken care of by a small surgical group who are particularly interested in this type of surgery. It is my purpose this evening to direct your attention to some of the more important features of fractures about the shoulder.

Before any fracture can be adequately treated, it is most essential to have a very clear idea of the displacement. If we are dealing with a fracture of the shaft of a long bone, little difficulty need be encountered in correctly interpreting the roentgenogragraphic appearances. This is likewise true of many joints, including that of the hip, in which the various prominences stand out clearly in the roentgenograms. But the shoulder joint presents many difficulties, as a perusal of the literature indicates. Most writers appear to be unanimous in thinking that the common displacement in a fracture of the shoulder is abduction and external rotation of the upper fragment, while the shaft is displaced to the inner side with a varying degree of upward displacement, with or without impaction. One searches in vain for any reference to flexion or internal rotation of the upper fragment, and only a few mention the anterior displacement of the upper end of the shaft. For some time I have felt that there is a great deal of misconception regarding this fracture. I have recently carried out some investigations which seem to substantiate this contention.

In the normal humerus, an anterior view will show just external to the rounded head a slightly constricted area, the anatomical neck, to which is attached the capsule of the joint. Immediately below the center of the head and blending with the neck is a cone shaped projection, the lesser tuberosity, which serves for the attachment of the powerful subscapularis tendon. It is slightly lower than the top of the great tuberosity which in turn is about an eighth of an inch lower than the highest point of the head. Immediately lateral to the lesser tuberosity is the bicipital groove which extends downward and slightly inward for some 2 to 3 inches on the shaft and lodges the long tendon of the biceps. Lower down the groove serves for the attachment of the latissimus dorsi tendon while the inner and outer lips provide insertion for the tendons of the teres major and pectoralis major muscles, respectively. Between the upper border of this muscle group and the anatomical neck lies the region known as the surgical neck of the humerus. To the outer side of the upper part of the neck is a flattened area representing the top of the great tuberosity and corresponding to the attachment of the tendon of the supraspinatus muscle. A very imperfect idea, however, is obtained of the shape of this tuberosity when viewed from the front.

Examined from the side it is seen to be an irregular quadrilateral about an inch and a quarter to the side. Its anterior border is straight and forms the outer lip of the bicipital groove which again is readily distinguishable. Anterior to this the conical projection formed by the lesser tuberosity is quite prominent. The upper border of the great tuberosity consists of two flattened surfaces. The more anterior of these is horizontal and, as mentioned, serves for the attachment of the supraspinatus tendon while the second, considerably longer, passes obliquely backward and downward at an angle of about 45 degrees and gives attachment to the infraspinatus tendon. The posterior border presents a

Fracture oration, presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

Fig. 1. Fig. 2. Fig. 3.

rounded contour and, together with a variable portion of the shaft with which it insensibly blends, serves for the insertion of the teres minor muscle. The lower border likewise fades into the shaft.

But while these various points are readily made out in a photograph, they are not so apparent in a roentgenogram, particularly when the upper fragment is rotated in one or more directions. In order to elucidate this problem the upper extremity was removed from a skeleton and the outlines of the lesser and greater tuberosities were marked by wires. Roentgenograms were then made with the arm in various positions. Figure 1 shows the appearance in the anteroposterior position, that is, with the arm supposedly by the side and the forearm pointing directly upward; or the same thing can be accomplished by having the forearm extended, but in that case the elbow must be close to the side and the palmar surface of the hand must be directed upward. In this slide the slightly constricted area corresponding roughly to the anatomical neck is distinctly visible and the great tuberosity stands out prominently on the outer side. Inasmuch as we are viewing it from the front, the wire which is fastened to its anterior, superior, and posterior borders looks very much like a fine hairpin. On the other hand, the wire which is fastened around the base of the lesser tuberosity appears as a wide, short loop. Between these loops an area of lesser density can usually be seen and this represents the bicipital groove.

Figure 2 shows the appearance when the bone has been rotated inward about 30 degrees. In this the constricted area of the neck is less evident and the fine hairpin appearance of the great tuberosity is giving place to one of much wider character; the outline of the lesser tuberosity widens slightly because now we are looking at this prominence, as it were, full face. Of more importance than the latter observation is the fact that a definite change can be made out in the position of the head which now points in a more vertical direction.

Figure 3 was taken with the forearm lying across the chest. In this the neck has for the most part disappeared and the head is directed almost vertically upward. The lines representing the greater tuberosity are now widely separated, and whereas the line depicting the posterior border in the previous slides was nearly straight, it is now bent markedly outward. The superior border of the tuberosity now stands out prominently due to the fact that the increased cortical thickening incident to the insertion of the supra- and infra-spinati tendons presents its maximum density when viewed from this angle. The lesser tuberosity again takes on an appearance which is very similar to that of the anterior view except that it is placed more internally.

But what is of the greatest significance is the appearance of a crescentic dense line with its convexity directed inward. This almost coincides with the inner margin of the head and when traced upward is seen gradually to disappear. It goes in the general direction of the upper border of the great tuberosity but is separated from that margin by the gap for the bicipital groove. This crescent is produced by the increased density about the base of the lesser tuberosity.

Figure 4 shows the appearance with the arm in full internal rotation, that is, with the forearm placed horizontally behind the back. Here the neck again becomes apparent but it is placed at an angle of about 90 degrees from that in the anterior anatomical position and the head is now directed upward and outward. The outlines of the tuberosities take on somewhat the appearance shown in the slide of the anteroposterior view, except that their positions are now reversed; but the feature of greatest significance is the conical projection of the lesser tuberosity on the

inside. The superior border of the great tuberosity does not stand out prominently as a distinct ridge because it is viewed rather obliquely, the direct result of extending somewhat the arm proper to permit the forearm to lie against the small of the back. This also accounts for the fact that the top of the tuberosity is so much below the top of the head. When the arm is externally rotated about 60 degrees, the appearance is that shown in Figure 5. In this the neck is quite apparent and the head is directed upward and inward. The wire around the base of the lesser tuberosity is represented as a fine hairpin with the ends almost in contact, and the apex of the lesser tuberosity points directly outward. The great tuberosity is outlined on the outer side by the straight line which corresponds to the outer lip of the bicipital groove. The anterior portion of the superior border of the tuberosity is also well marked but the rest of the border is less distinct and passes inward and downward. Indeed, the whole appearance is not unlike that in full internal rotation except that the various markings are reversed. This may be very confusing unless one takes into consideration whether the right or left shoulder is being examined.

In order to bring out the characteristic features when flexion is superadded, a picture was taken with the humerus rotated inward some 60 degrees and flexed about 30 degrees. Figure 6 is typical of such a position. The outline of the greater tuberosity is clearly defined as we are looking at it from its outer side, but instead of its upper border being slightly below the head, it is now above that portion of the bone. But a very interesting feature is now added in the cyst-like appearance which seems to fill the whole upper extremity of the humerus. It is caused by the slight density at the anatomical neck which in this view shows as a circle, inasmuch as we are looking at the head in a line directly opposite to the normal projection of that portion of the bone; or, in other words, if the tuberosities were removed up to the plane of the anatomical neck, the cut surface would be looking directly toward us. The projection on the inner side is due to the lesser tuberosity.

Fig. 4.

Fig. 5.

Fig. 6.

This aspect of the subject was further investigated on the cadaver. The upper end of the humerus was exposed by a long incision through the deltoid, the surgical neck sawed through in a transverse direction, and the movements of the two fragments investigated. Whereas it was an easy matter to move with the fingers the upper end of the shaft inward, outward, or in a forward direction, it was rather difficult to displace it behind the upper fragment. This was due to the resistance offered by the pectoralis major muscle, and when this attachment was severed, the shaft could be displaced backward with ease. The most interesting feature in regard to the upper fragment was the ease with which internal rotation could be accomplished, whereas external rotation, even to a very limited extent, required a very considerable twist. The tension on the subscapularis tendon naturally appeared to be the cause, but even after its division just proximal to where it blends with the joint capsule, there was little or no change, and it was only after dividing the supraspinatus tendon, just proximal to where it merges with the capsule, that the head could be rolled outward. Abduction, flexion, and adduction could each be brought about readily enough, whereas extension of the upper fragment was more difficult because of the close manner in which the posterior aspect of this portion of the bone is enveloped by the infraspinatus and teres minor muscles.

Figure 7 shows the appearance when the fragment is abducted and flexed 30 degrees and rotated internally about 60 degrees. In this the top of the great tuberosity can be

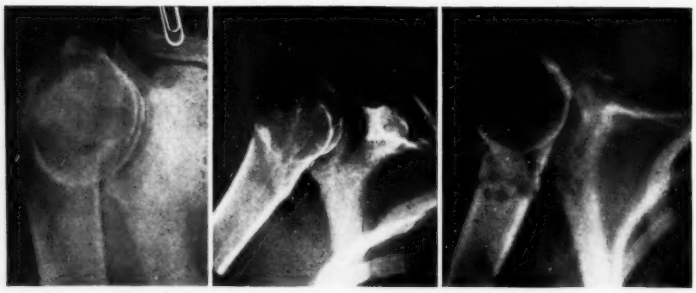

Fig. 7. Fig. 8. Fig. 9.

seen projecting over one-fourth of an inch above the outline of the head, while the contour of the lesser tuberosity almost reaches the margin of the head along its inner aspect. In addition, the cyst-like appearance is clearly visible. When the upper fragment is markedly internally rotated, flexed, and adducted about 20 degrees, the conical projection of the lesser tuberosity is visible on the inner side and the anterior margin of the great tuberosity can be seen extending vertically upward until it almost reaches the outline of the head which stands out just beyond the superior border of the great tuberosity. Here also, as in Figure 7 in which internal rotation was marked, the head is directed upward and outward. When the upper fragment is abducted and extended about 30 degrees without any rotation, the anatomical neck is readily discernible and the head is pointed well in an inward direction, but the most notable feature is the conical projection on the outer side. This is caused by the outer margin of the great tuberosity, and its resemblance to the lesser tuberosity is due to the fact that it is being viewed obliquely from above downward.

Having familiarized ourselves with the various appearances which the upper fragment may present, we are in a position to interpret correctly the displacement in any type of fracture. With this as a background, I have reviewed the x-ray films of one hundred cases of fracture of the upper end of the humerus in the x-ray department of St. Michael's Hospital. Naturally, a great variety of fractures is met with, but there are certain well defined types. The vast majority involve the upper aspect of the surgical neck not far below the old epiphyseal line and are more or less transverse. Apparently the older the patient, the higher is the fracture likely to be. The great tuberosity may be broken off alone or in association with a dislocation of the head, but it is commonly detached in a fracture in the upper limits of the surgical neck. Four common types of displacement were noted in the upper fragment—abduction, adduction, flexion and internal rotation, and it was found that a very constant relationship exists between abduction, flexion, and adduction and the position of the shaft. If the upper fragment is abducted, then the shaft is to the outer side, while if it is adducted, then the shaft is to the inner side. In this series there

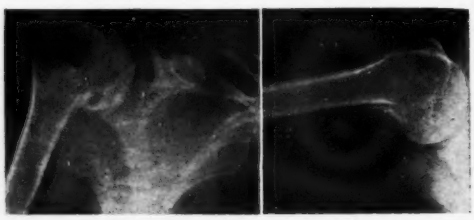

Fig. 10. Fig. 11.

Fig. 12. Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

was no exception to the latter association, but there were two in which the upper end was abducted while the shaft was to the inner side. This, I feel, was due to the position having become altered between the time of the accident and the taking of the film. A similar relationship appears to exist between flexion and an anterior displacement of the shaft, but this is not so surely determined, owing to the difficulty of interpreting depth with accuracy in stereoscopic anteroposterior plates; in only a few were lateral plates taken owing to the pain necessarily produced by abducting the arm sufficiently. But the similarity in the number of cases with flexion of the upper end to the number in which the shaft is displaced forward is very significant. Internal rotation of the upper fragment is of frequent occurrence. In some instances a moderate degree is doubtless due to faulty technique, as when the film is made with the forearm lying across the chest. Although it was twice as commonly associated with an adducted position of the shaft as with one in which the shaft was to the outer side, the relationship was not sufficiently constant to formulate a rule. There was not a single instance in which the upper fragment was rotated outward, and with the exception of the separated epiphysis in which a posterior position of the shaft is the usual condition, there was only one in which the shaft was found to lie posterior to the upper fragment, and in that instance the proximal fragment was extended. In only one other case in the series was the upper fragment extended.

These displacements are very interesting from the probable light which they shed upon the cause. Great care must be exercised in drawing conclusions as to the way in which an accident occurred from the description given by the injured, as very few people can give a reliable account. I have felt, however, that in the vast majority of instances the force is delivered to the region of the shoulder and the resultant displacement depends for the most part upon the position of the elbow at the time of the impact. A man cannot very well fall on the front of the shoulder unless he is carrying some object like a football and refuses to let it go. Instinctively the arm goes out to receive the impact and the common fracture is one that involves the wrist. But when he falls in a lateral or posterolateral direction, so rapidly may the feet go from under him that the arm cannot get back quickly enough to break the fall. Undoubtedly some force is commonly directed upward through the shaft of the humerus, and the position which the upper end finally assumes depends upon the

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

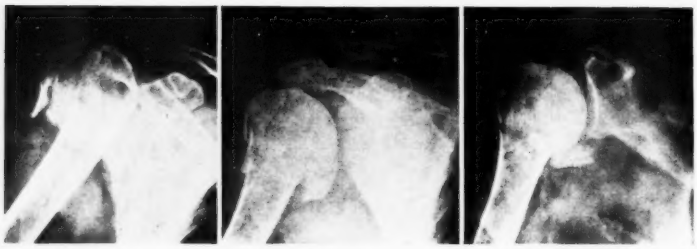

Fig. 21. Fig. 22. Fig. 23.

position of the elbow at the time of the fall. If it is close to the side and in the midaxillary plane, little change will be observed in the alinement, but there will likely be impaction; if it is away from the side a bit and still in the midplane, then the shaft will be displaced to the inner side with some adduction of the upper fragment; if it is posterior to this plane, then the shaft will be displaced anteriorly with flexion of the upper fragment. But in this instance, in addition to the flexion, the shaft may be displaced to either the inner or outer side, depending upon whether the elbow was to the outer or inner side of the sagittal plane of the arm when the break occurred. In my opinion it is the direct blow upon the shoulder which breaks the bone, a view that is supported by the fact that over 85 per cent of the cases in this series were of the transverse variety. Once a solution of continuity has been established, the displacement is largely due to the force transmitted along the shaft. This is derived from two sources, the pull of the muscles going from the shoulder girdle to the arm and that arising from the contact which the elbow makes with the ground. This does not, however, explain the prevalence of internal rotation which I believe to be due to the overpowering pull of the subscapularis muscle.

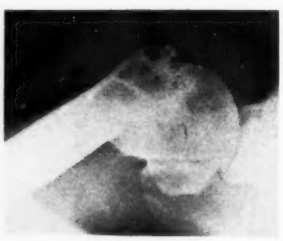

Fig. 24.

From the series under review, certain types of cases have been selected for illustrative purposes. While it is quite a simple matter to determine the displacement, provided one is thoroughly conversant with the details of the markings in the film, it is often impossible to reproduce these in a lantern slide. Consequently, many of the films have been retouched and this has been carried out by Eugene Shannon, head of the radiological department of St. Michael's Hospital.

Figure 8 is an example of fracture of the shaft directed to the inner side with adduction of the upper end, but in addition there is a very considerable degree of internal rotation of the upper fragment. This is very obvious from the outline of the top of the great tuberosity which is clearly delineated, and from the crescentshaped line with its convexity directed inward, produced by the base of the lesser tuberosity.

Figure 9 is a good example of the cyst-like appearance which is occasionally seen. The shaft is to the inner side and the upper fragment is adducted. The outline of the top of the great tuberosity is distinctly seen, its margin almost coinciding with that of the head, showing that in addition to a very considerable degree of internal rotation, the upper fragment is likewise flexed. This cyst-like appearance is not peculiar to a fracture of the upper end but is occasionally seen where the middle third of the shaft is broken. In such an instance it is necessary to place the lower fragment in marked internal rotation in order to get proper alinement.

In the series under review the shaft was to

the inner side in 42 cases, and of these, the upper fragment was adducted in 34; there were 6 instances of cyst-like appearance.

Figure 10 is an example of fracture of the shaft directed to the outer side with a moderate amount of abduction, internal rotation, and flexion of the upper fragment. The outline of the top of the great tuberosity is distinctly seen, and the density corresponding to the infraspinatus insertion overlaps this portion of the head. Figure 11 is a lateral view of the same fracture. In this the cone-shaped projection on the anterior aspect represents the lesser tuberosity, while the curved line which intersects the former and continues on to the outline of the head is the outer lip of the bicipital groove or, in other words, the anterior border of the great tuberosity. The flexion of the upper fragment is very obvious, but there is another very important feature, i.e., the marked prominence of the lesser tuberosity which proves that this fragment is very considerably rotated inward.

In this series there were 26 cases in which the proximal fragment was abducted, and of these, 24 had the shaft to the outer side. An impacted fracture with little or no other displacement is by no means a common type, and it is the variety which is most frequently mistaken for a sprain of the shoulder. Some of these are so firmly wedged together that it is impossible without using an unjustifiable amount of force to disengage the fragments even under an anesthetic. But the decision as to whether impaction has occurred from reading a roentgenogram is often open to doubt; we were reasonably certain, however, that it was present in 10 of our cases.

In a case of fracture dislocation of the shoulder, the roentgenogram showed the head broken off at the anatomical neck and lying in the axilla with its fractured surface directed upward and outward. The main line of fracture had gone through the anatomical neck and both tuberosities had been badly comminuted. This was the only case of this kind in the series, but in 2 other instances, besides the fracture of the humerus, there was a broken clavicle in one and a fracture through the surgical neck of the scapula in the other. In our series there were 2 examples of a separated epiphysis. In one the head was markedly abducted but without any rotational change, and the shaft was displaced upward to the outer side and backward. In a third case the epiphysis was displaced about one-fourth of an inch to the outer side, and carried with it a thin wedge from the outer side of the shaft. Most authorities claim that the typical displacement in this type of fracture is for the shaft to be shifted to the front, yet in the discussion they invariably depict just such a deformity as I have shown. In the dozen odd cases of complete separation of which I have records, the shaft has been to the outer side and posterior in all. This lends credence to the view that many of these injuries are due to a fall upon the outstretched hand.

This series of roentgenograms, while not including every variety, provides a very fair picture of what one is apt to meet in a fracture of the upper end of the humerus. I have not shown a fracture of the anatomical neck because in my experience a break through this region unassociated with a fracture involving the great tuberosity is extremely rare. In only one of this series was the head knocked off and that was complicated not only by much comminution of both tuberosities but by a dislocation as well. In very severe injuries the head may share in the general comminution of the upper end or it may be split into two more or less equal segments between which the great tuberosity may be so tightly wedged that it cannot be withdrawn without an open operation. In this series there were 4 instances in which the head was split. The great majority of fractures of the upper end of the humerus occur in people past middle life, and in these, comminution usually affecting some portion of the great tuberosity is common. It was present in 55 per cent of the cases of fracture of the surgical neck in this series, and from a study of these plates one gets the impression that the upward thrust of the shaft plays an important part in its production. Marked displacement of the shaft to either the inner or outer side was uncommon; in the vast majority it was less than half an inch. In only 12 instances was the separation about equal to the width of

the bone. It is in this type that shortening is likely to be marked. Table I gives in detail the important roentgenological findings.

Thus far we have dealt entirely with the roentgenological findings in arriving at a diagnosis because it is upon these alone that an accurate diagnosis can possibly be made. But the clinical evidence of a fracture must never be neglected and, in fact, this investigation shoud be carried out before resorting to the roentgenogram. When first seen the patient will be found steadying the arm against the chest and supporting it by the other arm. If seen early, there will be no evidence of ecchymosis, but the shoulder region will be swollen and invariably there will be found a spot corresponding to the surgical neck which is very tender to deep pressure. Measurement of the arm for shortening may give some useful information, but if there is much swelling, the landmarks may be difficult to detect. But shortening beyond a quarter of an inch or so was present in only 8 of our cases so that this method is not of much value in arriving at a diagnosis. If the shaft has been impacted into the upper end, the patient may be able to move the arm about through a considerable range without much discomfort, while if no impaction has occurred, active movements will be painful. In the latter event, gentle passive movements may be carried out through a narrow range without much pain. Although damage to important nerves and blood vessels is relatively rare in fractures of the shoulder, one should never fail to make sure that such complications are absent. To discover a nerve lesion for the first time after a fracture has been set may be very embarrassing to the surgeon if he has not previously examined the limb for such a complication. But injuries elsewhere should also be ruled out. If the patient be conscious, this is readily enough done, but if he is unconscious, it is comparatively easy to overlook quite an important injury. Indeed, such an associated injury may be much more important than the fractured shoulder.

Surgeons usually see these patients for the first time in a hospital so that the problem of how best to transport the individual to the place where the setting is to be done does not arise. It is nevertheless very important during this period, not only to lessen the pain as much as possible, but also to insure that no further damage to soft parts occurs. For this purpose the Murray-Jones splint is ideal; it not only provides adequate fixation but it restores the arm to something approaching the normal length which is an important factor in reducing the swelling. It has the further advantage that anyone at all familiar with first aid work need have no difficulty in applying it.

As soon as the roentgenograms have been studied and the exact deformity determined, the setting of the fracture should be proceeded with. There must be no waiting for the swelling to go down because the most effective way of decreasing it is the restoration of the fragments to their normal relationship. Furthermore, the earlier the fracture is reduced, the easier is the reduction, since delay simply allows time for the muscles to shorten.

A review of the literature discloses the fact that different authorities treat a fracture of the surgical neck of the humerus in a variety of ways. There is quite a consensus on the necessity of having the arm abducted. This position has the advantage that when active movements are begun, following union, the arm is in the optimum position because the difficulty is always in getting the arm up, not down. Then if ankylosis, a very rare occurrence, should supervene, the abducted position, provided it is not greater than 60 degrees, gives a much more useful arm in that it allows the maximum movement of the scapula. Some confine the patient to bed with the arm supported in a Thomas splint in an abducted position while others prefer to have him up and about with the arm abducted and supported on an aeroplane splint. As a result of our investigations we think that neither method is the correct one because neither takes into consideration either flexion or internal rotation of the proximal fragment, both of which are very common. The former was present in about half the cases in this series, while the latter displacement occurred in slightly over one-third. Indeed, the combination of flexion with internal rotation is a very common one.

It is a well recognized principle of treatment that where we have little or no control over a fragment, we must direct our effort to that fragment over which we have control; in other words, if we cannot bring the horse to the cart, we must bring the cart to the horse. Admittedly, a fracture of the surgical neck of the humerus is an example of this kind. The problem, then, is to ascertain the position of the proximal fragment, place the distal fragment in a corresponding position, and fix the fragments until union is sufficiently solid that gentle active movement will not disturb them. We believe that the establishment of proper alinement cannot be obtained by a routine placing of the arm in an aeroplane splint or by confining the patient to bed with the arm abducted and supported in a Thomas arm splint. For certain types of fracture, as, for example, those with an abduction deformity only of the proximal fragment, such treatment may suffice, although I can see no reason why a patient with an uncomplicated fracture of the shoulder should be confined to bed. But one must be careful lest too much abduction result in a downward angulation at the site of fracture. Many instances of this have come under our observation as illustrated in Figures 12 and 13 while in Figure 14 the position has been corrected by lessening the abduction. But where there is a variable amount of flexion, internal rotation, or adduction, such a procedure is bad and cannot possibly re-establish correct alinement. When the upper fragment of the humerus is internally rotated, the spinati muscles become flexors instead of abductors, and when the arm is put in the abducted position, these muscles keep up the flexion, thus rendering correct alinement in the lateral direction impossible. This is well illustrated in the anteroposterior view, Figure 15, and in the lateral view, Figure 16, and can be duplicated by illustration in most textbooks. Indeed, some authors, mistakenly, we think, regard this finding as an indication for doing an open operation. In our opinion there is no standard position in which the arm should be placed. Every fracture is an individual problem and the arm should be fixed in that position which most accurately establishes the alinement.

Having in mind the exact displacement, we proceed to set the fracture. If the greater tuberosity only is detached, no anesthetic may be necessary and the patient is seated on a stool. If the displaced fragment is mainly made up of the posterior portion of the tuberosity, the arm is best placed in 90 degrees' abduction and externally rotated, but if a considerable part of the anterior portion is also pulled off, abduction alone will probably suffice. In either event the extremity should be fixed in the desired position and this is best accomplished by encasing the chest and arm in plaster for 4 weeks. If the fracture is of the impacted variety and the position satisfactory, there is no necessity for fixation at all. The arm may be bandaged to the chest during the night and during the day carried in a sling from which it may be removed from time to time for gentle active movement, massage, or other form of physical therapy. But care must be exercised to make sure that impaction is really present. Roentgenographic appearances are deceptive, but if a considerable slab of the greater tuberosity is split off, the probability is that impaction is not very firm. However, cases of this kind are infrequently met with and present little difficulty.

The ones with a considerable degree of displacement of the proximal fragment are those most frequently encountered and the ones which present the greatest difficulty in setting. We accomplish this by reducing the fracture on a fluoroscopic table which is provided with a second tube whereby a lateral view can be obtained. The patient is given a general anesthetic and a mattress some 4 inches thick is placed beneath the pelvis and lower extremity, while the shoulder rest is adjusted under the upper part of the back and head. The shoulder rest is of very simple design. If a snugly fitting stockinette has not been previously applied to the trunk and upper arm, it should be adjusted now. The lights are then turned off and sufficient time allowed to get the eyes ready for screening. The forearm flexed to a right angle is then held in a vertical position and the fracture examined by means of the screen. The fragments are then manipulated and the distal fragment or

TABLE I.—IMPORTANT FEATURES OF 100 CASES OF FRACTURE OF THE UPPER END OF THE HUMERUS

| | Cases |
|---|---|
| 1. Fractures of the surgical neck | |
| 1. Transverse | 78 |
| 2. Oblique | 13 |
| 3. With dislocation of head | 1 |
| 2. Separated epiphysis | |
| 1. Alone | 2 |
| 2. Associated with fracture | 1 |
| 3. Fracture of great tuberosity | |
| 1. Associated with fracture of the surgical neck | 50 |
| 2. Alone | 4 |
| 3. Associated with head dislocation | 4 |
| 4. Rotation of the upper fragment | |
| 1. Internal | 38 |
| 2. External | 0 |
| 5. Adduction of the upper fragment | 34 |
| Shaft to the inner side | 42 |
| 6. Abduction of the upper fragment | 26 |
| Shaft to the outer side | 24 |
| 7. Flexion of the upper fragment | 47 |
| Shaft anterior | 39 |
| 8. Extension of the upper fragment | 2 |
| Shaft posterior | 2 |

shaft is made to conform to the direction of the proximal end. If the arm can be abducted 60 degrees at least, so much the better, but it must not be moved outward farther than conformation of the upper fragment will allow. If in this position the neck can be visualized, one may be sure that there is very little, if any, internal rotation, but if, on the other hand, the upper fragment appears as a uniform expansion of the shaft, resembling somewhat a tetanus bacillus, we know that we are looking at the external or lateral aspect of the upper fragment and, therefore, that it is very considerably internally rotated. In the latter event the forearm is rotated inward about 60 degrees.

Whether the forearm is now pointing in a vertical or nearly horizontal direction, the next thing to find out is whether the alinement in the opposite direction is satisfactory. This position of the arm being maintained, the patient is rolled over about 45 degrees, the injured shoulder being kept uppermost and the lateral screening carried out. The tube is adjusted to allow the rays just to miss the anterior chest wall and to pass through the shoulder in an oblique direction while the screen is held against the back of the shoulder. Although this is not a true lateral view, there is no difficulty in determining the position of the fragments and in obtaining a satisfactory alinement by changing the position of the lower fragment to correspond to that of the upper. This corrected position is maintained while the patient is again turned on his back and the fracture once more examined from the front to see if the alinement in this direction is still satisfactory, and any necessary correction is made. The lights are then turned on and plaster is applied to the trunk and to the forearm and to the lower two-thirds of the arm with the elbow at a right angle. This leaves the region of the shoulder free so as not to interfere with the subsequent screening.

A plaster brace about 2 feet long is then prepared and the central portion is twisted into a rope long enough to reach from the trunk plaster to the elbow which is held in the previously determined position. While an assistant exerts moderate traction upon the forearm, the split ends of the brace are bound to the trunk and elbow, respectively. The lights are now turned out again and the arm is held steady until the brace begins to show signs of hardening, at which time the anterior screening should be carried out and any necessary change made. Then as soon as the brace is firm enough to support the arm when very carefully handled, the patient is rolled over and screened in the lateral oblique direction and any necessary alteration made. When satisfactory, a plaster spica is applied to the shoulder, thus effectively binding the trunk and arm plasters. When the plaster has set, the brace may be either cut away or left.

Check-up plates are made the following day in the anteroposterior position and either the lateral or oblique lateral direction. If the arm has sufficient abduction, one plate should be taken in a lateral direction, that is, with the rays coming down over the top of the shoulder, but if the abduction is not great enough to permit this, then a plate should be made from an oblique lateral position instead. If the setting is considered satisfactory, the patient is allowed out of bed and may go home the following day. Figures 17 to 20 illustrate the result in a case in which a

lateral plate could be obtained. The anteroposterior view, Figure 18, shows an apparently good reduction, yet the lateral picture, Figure 19, shows marked flexion of the proximal fragment. Figure 20 shows the corrected position which was obtained by changing the arm from abduction to flexion. Figures 21 to 23 illustrate a case in which a lateral oblique exposure was used. Obviously these would be classed as satisfactory settings, but in arriving at a conclusion as to what constitutes a sufficiently good alinement, the type of injury must be taken into consideration. If the whole upper end of the humerus is badly comminuted, anatomical replacement must not be expected from any type of manipulation, in which event, if the upper end of the shaft can be made to conform to the general outline of the upper end in two directions, the setting should be considered satisfactory provided the elbow is abducted about 60 degrees and in such a position that the hand can touch the mouth. The alternative, of course, is an open reduction, in which event one must very seriously consider whether the end-result, having in mind the age of the patient, is likely to be improved by the operation.

The cast should not be disturbed for a period of 4 weeks, at which time the roof should be removed from the arm portion to allow the limb to be lifted out from time to time. At first this should be done by the surgeon, but in a day or so the patient should be encouraged to carry out the various movements, gradually increasing the range. At the end of a fortnight the remainder of the cast may be cut away. During this period advantage may be taken of the benefits to be derived from massage and other physical therapeutic measures to hasten the progress. These are of undoubted benefit and should always be recommended where feasible, but it cannot be too strongly emphasized that active purposive movements are the essential factors in the restoration of function. To a certain extent the end-result depends upon the age of the patient, the severity of the fracture, and the tendency of a person of advancing years to develop osteo-arthritis, but in the vast majority of instances a poor result is caused by inaccurate setting. This viewpoint is based on an examination of anteroposterior and lateral roentgenograms of individuals with various degrees of frozen shoulder following a fracture of the upper end of the humerus. In these the anteroposterior films may usually be classed as satisfactory, but invariably the lateral ones show gross displacement with the shaft displaced anteriorly and the upper fragment flexed, either with or without internal rotation. I have never seen one in which the shaft was posterior. Figure 24 is typical of these cases.

As for the fracture dislocations, an attempt should always be made to reduce the head by manipulation under a general anesthetic. Then, if successful, we proceed to set the fracture as previously outlined. During the manipulation we grasp the elbow in one hand and exert some control over the upper end of the shaft with a foot in the axilla; we feel that the latter procedure is a real help. In any event, we have been successful in reducing the head in the last 5 instances which we have encountered. Should manipulation fail, an open operation must be done, in which event one should be very guarded in the prognosis, as few individuals past middle life can have any sort of major operation on the shoulder without some residual loss of movement.

# EARLY LOCAL CARE OF FACE INJURIES

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EXCEPTING trauma of vital organs and their essential coverings, the final outcome of no injury is so directly dependent upon early proper care as injury of the face.

In the late war, special provision was made for the care of such injuries, and results appeared to substantiate this foresight on the part of the surgeon general. There were more than 8,000 facial injuries, 3,000 of the patients dying of their wounds. Of those eventually returned to this country as casualties, the majority had been injured in the earlier engagements before special provisions for care of facial injuries had been put into general operation.

In civil life, automobile accidents are especially prone to produce face injuries of a grave type, industrial accidents adding many more. Observation of a number of these cases at later periods would seem to warrant the conclusion that today many are not receiving the most appropriate care.

The bone and cartilage framework encloses the orbital cavity, mouth, nasal passages, maxillary and frontal sinuses, and external auditory canal, in addition to supporting the external tissues and giving attachment to the muscles of expression and mastication and to the teeth. The whole is made to a form that both silently and articulately expresses the emotions and, more or less plainly, the spiritual character. It is the laudable desire of most normal individuals that the face present a pleasing, or at least not a displeasing, appearance, and here injuries that might be negligible in almost any other part can bring about most grave consequences. Appearance or function of these related structures can be compromised by a bony displacement, and displacement which is allowed to persist until natural fixation occurs too often eliminates the possibility of correction or restoration by surgery.

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Though the tissues are more highly resistant to infection and heal with greater facility than those of almost any other region, mucous crypts and sinuses, skin tubules and the predental tissues can harbor potentially virulent organisms that occasionally become active after injury.

Replacement of bone to approximately normal position is easily accomplished by employing the right means at the right time, but both time and means differ with different injuries, and haphazard results will often follow haphazard methods.

Excepting direct bone fixation, the teeth are the only means of obtaining absolutely accurate and stationary anchorage for mobile bone fragments, and fractures of tooth bearing bone are most easily and accurately fixed in place by fastening the teeth of one jaw to those in apposition with it, a procedure instigated and popularized by the late Thomas Gilmer (Fig. 1). Direct bone fixation at the fracture site by a strand of prepared tendon or very fine silver wire passed through drill holes in the bone is a plan with which most surgeons are quite familiar.

## FRACTURES OF LOWER JAW

With the following exceptions, simply wiring the lower to the upper teeth, in occlusion, will suffice in most fractures in any part of the lower jaw.

A. Lack of a usable tooth in an otherwise uncontrolled posterior fragment will demand some supplementary fixation (Figs. 2 and 3). Several plans are available: direct bone wiring, fixing the coronoid process by a screw through the zygoma, some sort of dental splint, or backward tension on a silver wire engaging the posterior border of the ramus and protruding through the skin wound. If the patient is seen early, the direct bone wiring is usually applicable, and if this can be done through the alveolar process or through the bone posteriorly and around the tooth neck in front, it is

usually the simplest plan. The lingual nerve must be avoided.

B. Lack of a needed tooth in a key position in the upper jaw is the second exception. Here a wire arch made from some special material or a piece of stove or baling wire can be attached to the necks of the remaining maxillary teeth by fine wire ligatures and will give adequate upper fixation for the lower tooth wire (Fig. 4).

C. A corresponding lack in the lower arch, the third exception, can be met by placing one or more circumferential silver wires entirely around the sagging fragment upon which upward traction can be made (Fig. 4).

D. Interdental wiring might not satisfactorily eliminate movement at a true symphysis fracture. Here some other plan may be needed as a supplement or as a substitute. A low bone "wiring" made through a transverse incision along the lower border of the mandible just under the chin is the surgeon's most facile plan. This should be accomplished with prepared tendon or through-and-through lacing with a strand of very fine silver wire. The latter might require removal later which is not always easy. If the teeth are adequate, a Gilmer posterior band splint is a better plan.

In fractures of the neck, condyle, or intramuscular part of the ramus, we have been content simply to fix the body of the lower jaw to the upper by interdental wiring and so far have seen no reason to regret our conservatism (Figs. 5 to 7).

Backward displacement of the chin fragment in a double fracture in the forward part of the body can usually be controlled by interdental fixation (Fig. 6). If seen later, forward traction can be obtained from a forward extension bar on an upper dental splint (Fig. 9), an outrigger from a plaster head-cap, or a counter weight working on a pulley fixed to bed or ceiling (Fig. 10). In all instances of backward displacement, a tight pressure with a Barton or 4-tail bandage is contra-indicated until after replacement and fixation are established. This type of bandage produces backward pressure, which is the reverse of what is desired. In a comparative study, two large series of cases, one treated with chin cup and bandage and one having no treatment, had on the average equally poor results (Fig. 11). The proper relations of a displaced downward chin fragment, not otherwise controllable, can be maintained by the use of an open bite splint (Gunning type), which relaxes the pull (Fig. 12) of the mandibular hyoid muscles.

Fracture through the body of an edentulous mandible (Fig. 5) can be fixed in place by circumferential wiring of the attenuated lower jaw to the patient's lower dental plate in one or more places and then attaching the lower to the upper plate. If need be, the two dentures could be fixed together as an open bite splint (Fig. 13). Either way, this had best be done in collaboration with the dentist.

The simple fixation of the jaws together by wires can be done by anyone of ordinary surgical skill, but those not familiar with this technique may find the patient's dentist a very desirable coworker. The soft iron wire used by florists comes in short lengths and is a convenient material for interdental wiring. With fine wire less damage will be done to the gums. Wire made especially for this purpose can be obtained from a dental supply house. While and after the teeth are wired or banded, the gums should receive care.

A real inconvenience of interdental fixation is the closed mouth, but with the help of the kitchen food grinder and an invalid feeding cup or a large syringe with a rubber tube attached, the patient can be given any kind of food desired in any quantity and without the sacrifice of a natural tooth. Possibly for a few days, food and water might best be given through a small intra-esophageal catheter passed through the nose and fixed to the cheek by adhesive plaster.

On the whole, interdental wiring is the safest, simplest, and most universally acceptable form of treatment. The dental fixation can usually be dispensed with before firm union is obtained, and the time can be shortened by substituting some form of dental splint. One of the simplest and best is the Gilmer posterior band splint (Fig. 14). The strength of the union should be determined by means of finger pressure, for the roentgenogram will demonstrate the line of fracture very distinctly long after a usually firm union has occurred.

Every fracture that traverses a tooth socket, at which there is any perceptible movement, should be regarded as compound and should be immediately drained through an external incision made just under the lower border of the bone. In doing this, the point of the knife should be made to slip up into this gap. Death will very rarely result from the want of this precaution, but abscess, prolonged induration, delayed union, necrosis of comminuted fragments, extensive loss of bone substance, or grave sepsis can be prevented to a very large extent by this simple procedure. If the incision is properly placed, it can later be made invisible, if need be, by excision and resuture of the scar. When seen early, the patient's condition permitting, fractures of the body of the lower jaw should be immediately replaced and fixed and necessary drainage established (Fig. 15).

The displacements in mandibular fractures are dependent upon muscle pull, while, with the exception of a downward pull of the masseter muscle on a double fractured zygomatic process, the displacements in maxillary and nasal fractures are, as a rule, due either to gravity or to the original violence. An impacted fracture of the lower jaw is almost inconceivable, while those of the upper are of common occurrence.

Fracture of the lower jaw, like fracture of an extremity, might be conceived as more of a benefit than a calamity, because of the force expended that otherwise might have been transmitted to more vital structures (Fig. 16). Dislocation at the joint must cause a gross derangement of occlusion, but in spite of this it is sometimes overlooked.

### FRACTURES OF THE MAXILLA

Considered in relation to fractures, the term maxilla includes all of the bones of the face with the exception of the frontal bone and the mandible—all together, including the lachrymal and the lateral masses of the ethmoid vomer, and parts of the sphenoid, forming one integral mass, in which fracture lines disregard anatomic boundaries. In treatment, a distinction exists between the more solid tooth bearing part of the maxilla and the more articulate framework of the superstructure.

*Alveolar process and palate.* Fractures of the alveolar process of either jaw fit roughly into three classes: those in which a section of the outer or inner table is pushed buccally, labially, or lingually, frequently carrying with it still attached teeth; those in which a mass of alveolar process, including the contained teeth, is torn loose from the body of the bone; and those in which the plane of fracture traverses both the alveolar process and the body of the bone, which in the mandible really constitutes the ordinary fracture of the body. The mucoperiosteum which carries a good blood supply is so closely adherent to the alveolar bone that it is seldom that any considerable fragment of the latter is ever completely separated.

In every type of alveolar fracture the displaced fragments and the teeth which are still attached should be replaced as accurately as possible and retained either by wires or some other dental appliance. Teeth that are to be retained after the bone has united should immediately or ultimately be placed in the care of the dentist.

The upward tilt of a stellate fracture of the palate process requires only replacement by pressure along the floor of the nose.

*Superstructure.* The loculate mass above the palate can be broken in any direction, but besides a conceivably possible vertical separation of the two halves of the maxilla, there are three somewhat distinct general types. The first is along a more or less transverse plane, partial or complete, through the antra, with or without radiating fracture lines through the palate or alveolar processes, with usually little tearing of the oral mucosa. The whole palate or a portion may be quite movable, and if so, the case is treated as will be described for complete transverse fractures through the orbits. If there is any impaction, the displaced fragment should be freed before fixation is attempted. This is particularly important when the impacted palate portion has been driven upward and backward. If this is not repositioned, the persisting lack of occlusion and evident facial deformity may be of minor importance as compared with the impairment of hearing that can result from crowding of the Eustachian cushions and orifices.

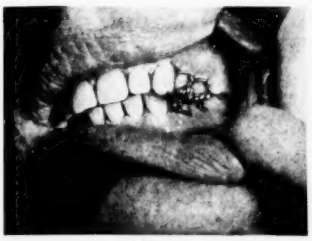

Fig. 1.

Fig. 2.

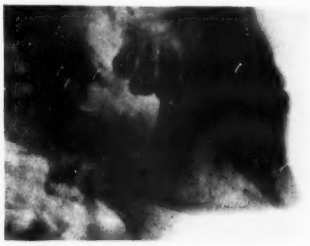

Fig. 3.

Fig. 1. Fixation of upper jaw to lower by means of the teeth. Simple Gilmer reciprocal wiring is accomplished with soft florists' iron wire. There are modifications of this plan.

Fig. 2. Ramus body fracture. Posterior fragment controlled by retained third molar tooth. This tooth will be later extracted both on account of the broken mesial root and also because the distal root is situated in the line of fracture.

Fig. 3. Ramus body fracture, uncontrolled. Note the attempt to maintain apposition of the fragments by an inadequately placed wire which has done more harm than good.

Another classic plane of transverse fracture is through the orbits, nasal cavity, and pterygoid and zygomatic processes. This may be but a fissure in the bone with little tearing of the covering, to be detected only by eliciting a slight movement while grasping the vertex firmly in one hand and the dental arch with the thumb and fingers of the other; or the whole detached mass may sag down one-half inch or more, giving a characteristic elongation to the face. This fracture may be complicated by extension through the skull and dura. Not infrequently there is injury to the sixth nerve, or much more serious, the globe may be damaged or the optic nerve crushed or divided. We have fortunately never seen this latter occur bilaterally. No matter how slight the mobility, a possible fracture into the base should always be considered.

In fractures of either plane with no displacement and little excursion, one might rest content with prohibiting all chewing for 3 weeks, being alert to a possible increase of the false movement. In these transverse fractures, the basic principle of treatment is the same as for fractures through the substance of the lower jaw, namely, fixing the dental arches in occlusion, or if there are no teeth, the patient's dental plates can be used as in edentulous fracture of the lower jaw. Either with or without teeth, interdental wiring or a denture splint will maintain the proper relation of jaws to face even when the lower jaw is also badly fractured, this being dependent on an acquired habitual tension of muscles of mastication.

In most lower jaw fractures, the earlier the reduction and fixation, the better, and this is true of gravity displacements of simple transverse fractures, but with comminutions or impactions of the upper loculate part, a week or 10 days on the average had best elapse before restoration is attempted. One reason for this interval is to bridge a period of possible spreading infection from quiescent foci; another reason is that this time can be profitably used to improve the general and local condition of the patient.

There is usually nothing in the orbits that needs attention in the upper transverse fracture. An incidental downward displacement of the globes (Fig. 17) and displacement of the process in single zygomatic fracture should in

Fig. 4. Essential teeth missing or inadequate. This roentgenogram shows lack of teeth in the anterior fragment, which is compensated for by passing a silver wire completely around the chin fragment and, lacking adequate anterior dental anchorage above, this circumferential wire is fixed to a wire arch fixed to the distal teeth.

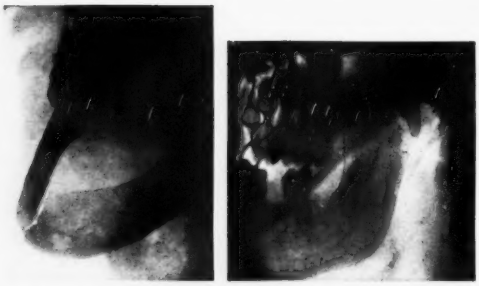

Fig. 5, left. Symphysis fracture. In this case the bone is edentulous, but even with a full set of teeth a truly central fracture cannot be controlled by simply wiring the upper to the lower jaw.

Fig. 6. Fracture of the condyle, neck, or adjacent part of ramus. Showing the fixation of the jaws in natural occlusion and no direct replacement or fixation of the fragments.

uncomplicated cases automatically fall into place by the repositioning of the maxillary mass. In the lower transverse fractures, intraoral displacement should be molded into position. Unless symptoms dictate otherwise, the antra need not be opened, but patulence of the nasal passages must be assured.

Fracture in either the upper or the lower plane may cause obstruction to nasal breathing from mucous swelling, if not from bony displacement, and this swelling might also extend to the mouth and pharynx, so that immediate fixation of the jaws in occlusion might seriously embarrass respiration.

Gravity displacement in the predental fixation interim can be most simply and very

Fig. 8, left. Backward displacement of edentulous chin fragment.

Fig. 9. Backward displacement of chin fragment. Held forward by circumferential wires attached to a prolongation of an upper dental splint. This traction can also be made from a wire spring bow incorporated in a plaster head cap.

Fig. 7. Fracture of condyle, neck. The free mouth opening which has followed in all our cases treated by reciprocal dental fixation, but with the chin drifting toward the fractured side as the mouth opens. This latter fault will most likely improve rapidly in the next few months.

effectively corrected by the use of a Kingsley splint reversed, held up by a slightly elastic pull. This splint was formerly regarded as a proper permanent fixation for these sagging fractures, but if there is comminution at the line of fracture, the upward pull can easily overcorrect or inaccurately correct it, thus causing a discrepancy in occlusion which could seriously compromise an otherwise good result. For this reason the jaws should be fixed in occlusion within 2 or 3 weeks after injury.

Another classic displacement of this region depends upon a fracture displacement of the malar bone which is almost always impacted (Fig. 18). One common displacement is inward and backward; another is slightly downward, and outward, and backward; the latter may interfere with the forward movement of the coronoid process of the mandible, thus limiting mouth opening. In either instance, the continuity of the lower or outer and lower orbital borders, and of the floor of the orbit is more or less disturbed. One of the most commonly slighted complications is a downward or backward displacement of the globe, because it is so easily overlooked in the earlier period.

The following plan of treatment of fracture displacements of the malar bone is based on two things—the observation of a considerable number of penetrating wounds of the antrum from all ordinary types of war missiles, in various stages after injury, and the experience gained in the treatment of these fractures in civil practice.

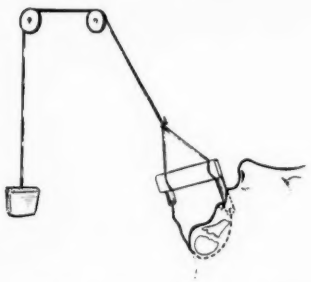

Fig. 10. Backward displacement of chin fragment. Controlled by continuous traction of a counter weight.

Usually under a general anesthetic the mucosa is incised and a chisel is driven into the antrum above the first molar or premolar teeth. In a mass displacement of the malar bone, the impaction can be freed and replacement accomplished by the leverage of a heavy curved urethral sound from within the antrum combined with digital manipulation from without. The cavity can be gently, but with some firmness, and methodically packed with a one-inch or wider folded strip of iodoform gauze, lightly impregnated with balsam of Peru, so placed as to maintain the bones in position, and also as to be withdrawn without snarling. The cavity can be irrigated daily through an included Dakin's tube and the gauze removed 2 or 3 weeks later.

Many, if not most, fracture displacements of the malar bone can be approximately if not perfectly replaced by inserting a long, slender bone elevator into a small opening at the upper part of the temporal ridge, following the bony wall of the fossa, and engaging and prying the malar bone into position. This is simpler than the intramaxillary approach just described.

Backward displacement of the frontal process of the maxilla can be pried forward with a chisel inserted through the nasal cavity, and a crushed in frontal sinus wall can be pried out by inserting the chisel into the sinus from just under the orbital border. From no part of the face, however, should any still attached bone ever be removed at the time of the injury (Fig. 19).

A blow of a hard object, such as the end of a pole or the loose end of a culvert railing,

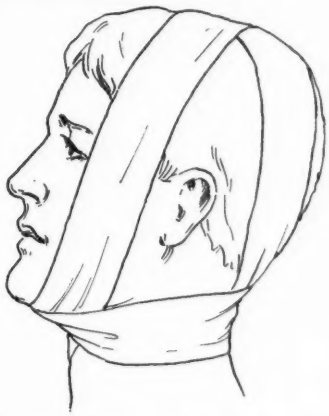

Fig. 11. Modification of the Barton bandage to eliminate the often objectionable backward pressure on the fractured body. A snug bandage will often give a sense of comfort to the patient and it may be needed to hold a dressing in place. An elastic bandage is likely to be more comfortable than one with no stretch.

against the upper part of the bridge of the nose will tend to drive the nasal bones either backward between the frontal processes and under the frontal bone or even under the cribriform plate of the ethmoid (Fig. 20), or it may flatten the nasal roof angle and push outward the frontal process with its anterior lachrymal crest, and perhaps the lachrymal bone, so as to impinge into the orbit, causing an increased distance between the inner canthi. Never having seen one of these in the recent state, we are not in a position to speak with authority, but it would seem that if seen

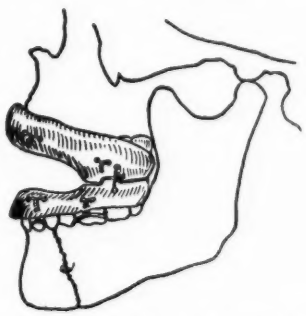

Fig. 12. The Gunning splint. Releases the downward and backward pull of the mandibular-hyoid muscles. This splint can be made in many forms and various materials, including the patient's own dentures.

Fig. 13. Bilateral body fracture of an edentulous lower jaw. This can best be controlled by the use of a Gunning type splint. Left, facial distortion due to malunion following direct bone wiring. Right, result obtained by opening the malunion, using a Gunning splint to which all three fragments were attached by circumferential wires.

early, an immediate correction might be obtained by prying forward under the depressed nasal bone with a small urethral sound and at the same time using a sharp toothed lion forceps to compress mesially the outspread bony masses. Following such a manipulation, the patency of the nasal duct and the infundibulum should be checked before any consolidation occurs. We can emphatically assert that the late correction of this condition is quite a formidable procedure. If the blow described above lands lower down on the nasal bridge, or if the nasal bridge lands squarely and forcefully on a hard surface, the arch may either flatten and spread laterally in front of the frontal processes or be driven between them.

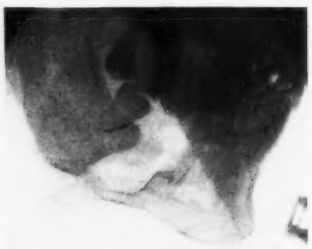

Fig. 15. Loss of bone substance in a comminuted fracture, due most likely to lack of early inferior external drainage to the site of fracture. The wiring of the remaining fragments in their proper relation to the upper jaw will prevent facial distortion, preserve occlusion, and insure a useful jaw should there be sufficient bone reproduction to fill the gap.

Fig. 14. The Gilmer posterior band splint.

In either case, an intact nasal septum must crumple to permit this, and the latter should always be straightened at the time the bridge is raised (Fig. 21). If any of the intrinsic nasal cartilages are torn or detached, they should be repaired by intranasal or extranasal suture at the same time.

After the bones are raised and the septum is straightened, the nasal bridge may retain its normal contour. If not, the bones can be held accurately in place by an adjustable intranasal bar of metal attached to a dental splint (Fig. 22). The flattened lateral spread of the bridge, if not comminuted, can be peaked up by the dental splint, or a wire mattress suture can be passed through the full thickness of the nasal wall and the septum, traversing the fracture line, and tied over a lead plate on each side. Laterally, force may have pushed the bridge over to one side and usually it is a simple matter to push it back in place where it will remain. If not, we have a choice be-

Fig. 16. Malunion of body fracture made possible by (1) loss of bone at fracture site, (2) lack of fixation of the remaining fragments in their natural positions. Right, later restoration, which required two separate operative procedures: (1) opening the malunion, fixing the fragments in natural position, and filling the resulting gap by drawing in the neighboring soft tissues. This will later serve as a suitable bed for a bone graft; (2) bridging the gap with some form of bone graft after the interposed soft tissue has thoroughly healed in place.

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 17. Maxillary fracture. Left, permanently displaced malar bone and orbital border following an uncorrected fracture. Right, later correction, releasing the displaced soft tissues and building up with cartilage inlays.

Fig. 18. Maxillary fracture. Left, downward and outward displacement of malar bone. Right, result of elevating the displaced fragment.

Fig. 19. Bone loss. Left, loss after removal of bone from comminuted fracture. Right, later, partial restoration with cartilage and bone transplants.

Fig. 20. Depressed nasal fracture. Left, a much greater displacement, the bony bridge having been driven backward between the frontal processes. Most likely at the time of injury the patient was not in condition to permit proper replacement of the displaced bridge. The result shown in right photograph, which bore little resemblance to the original condition, was obtained by chiseling the bridge free from the frontal process, prying it partially forward, and later inserting a cartilage transplant.

Fig. 21. Depressed nasal fracture. Left, bones spread laterally, bridge flattened. The septum has crumpled and the nose is shortened. At the time this case was seen it was still possible to pry the nasal bones forward, where they were held by a splint attached to the teeth, but the upward tilt of the tip and alæ persisted. This was later corrected by freeing the alar from the upper lateral cartilages and moving the former forward and downward on the lower border of the upper cartilages. Result is shown at right.

A B C

Fig. 22. Traumatic growth deformity. This seems occasionally to follow a nasal injury in early childhood, at which time displacement can rarely if ever be detected. A, The condition in early manhood, which was corrected by chiseling free the distorted bridge and palatal attachment of the septum and then holding the remolded nose in proper position by an outrigger attached to a dental splint, B. C, Final result.

tween two plans of retention. If the nasal bones are not shattered and the upper part of the septum remains intact, a silver wire can be made to engage the bridge at the lower border of the bony part; this wire traverses the opposite nostril, passes through the cheek tissues to emerge into the mouth, and is fastened to a bicuspid or first molar tooth. It can be worn with little discomfort and is invisible. It is withdrawn through the mouth after 2 or 3 weeks. If the anterior nasal spine is displaced and impacted, it can be freed with a chisel driven through the upper fornix. If there is much comminution or splintering or separation of the nasal bones, then the dentally attached splint referred to above will be more effective.

Except as support to the septum, intranasal packing is ordinarily just about as helpful in accurately holding fractured nasal bones in place as the chin cup and 4-tail bandage for a mandibular fracture. Either can expedite soft tissue healing and both give a sense of security to the patient, but neither can hold a displaced bone fragment in its exact position.

A recent blow on the nose of an infant or growing child presents a peculiar problem. Many very marked deformities of the nose have, according to the history, developed gradually during the growing period, starting soon after a nasal injury that at the time was often thought to be trivial by the physician who was consulted at the time (Fig. 23). We have made it a rule in every case of a baby or child so injured to explain the supposed pos-

Fig. 23. Nasal fracture with lateral displacement. Left, uncorrected fracture of some years' duration. Right, result after switching osteoplastic flaps.

Fig. 24. Suture scars. Left, scar of a cheek wound and also scars from the suture used in the primary repair. Right, condition 6 years after original wound; scar was excised and resutured with buried silk. Note the original suture scars still persisting.

Fig. 25. No suture scars. Left, condition after wound had been allowed to heal without suturing. Right, final repair unmarred by suture marks.

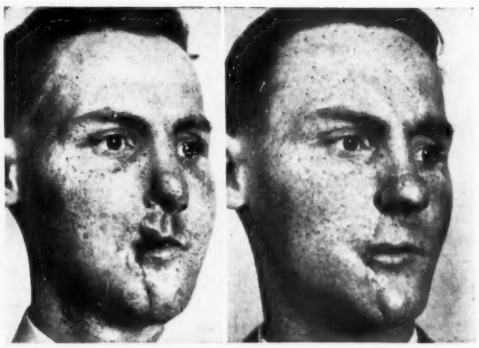

Fig. 27. Extensive wound with loss. Left, loss of parts of mandible, chin, upper and lower lip, and the right ala nasi. Right, what was accomplished by a later adjustment.

sible results of such an injury, and if permitted, to make forceful forward pressure on the bony bridge from within, on the theory that the later hardening and distorted growth of the septal cartilage which seems to be the basic factor in these developmental deformities might have been induced by the abnormal backward pressure of imperceptibly depressed bone.

The keynote of the case of face fractures is exact reduction and retention before solidification occurs. In few instances can a secondary repair of a fractured face bone equal what could have been much more easily accomplished at the primary treatment. This also holds true for the cartilages, but in injuries of the soft tissues, early repair is not always the prime objective. The two important things are not to sacrifice any tissue at the time of injury and not to place and retain sutures that will leave scars (Fig. 24).

A B C

Fig. 26. Extensive wounds. There are often reasons why these cannot, or had best not, be sutured at the time of injury, but with the exception of certain overlong or thin flaps, bound to become distorted in the healing, the final result is seldom compromised by this lack of early closure. A, A shell wound which cut to the bone and was dressed open. B, The result of spontaneous healing. C, What was accomplished by a later adjustment.

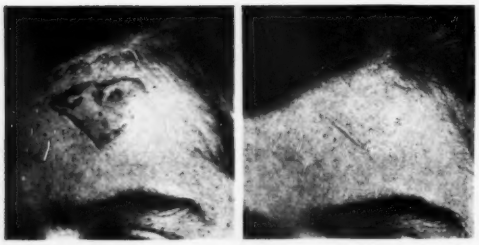

Fig. 28. Trap-door flap. Left, a full thickness forehead flap that had been raised superficial to the periosteum by a glass cut which also divided all deeper layers of the pedicle to, and partly into, the deep surfaces of the overlying derma. At the time of injury the discoloration of the undercutting was visible from the skin surface. Any attempt accurately to suture this flap in place at this time would almost certainly have caused its death *in toto*. One tacking suture was used to insure anchorage and a gentle pressure dressing was applied. Some epithelium was lost but quite a usable part of the flap survived as shown. Right, later some of the damaged part and the bordering scar was removed and, by undermining the scalp, we were able to suture remaining part in place without distorting brow.

Fig. 29. Tattoo, road oil. It is improbable that scrubbing will remove embedded oil. Ordinary care usually is sufficient at the time of injury. Later the oil-stained scars can be excised, and where needed a flap or skin graft will replace the excised scar. Left, oil tattoo which was excised and partially sutured, while quite an area was covered by a full thickness graft of skin from behind the ear as shown at right.

### REPAIR OF SOFT TISSUES

Often in attempting a secondary repair of the soft tissues, one is more embarrassed by the suture marks of a primary suture than by the scar of the injury, and when the situation is further complicated by loss from a débridement, the repair may be much more difficult and the result jeopardized (Figs. 25 to 27). In these illustrative cases the face had been torn wide open and allowed to heal apparently without sutures or other means of retention.

With clean cuts in any part of the face, the attempt should be made to obtain primary union, as the resistance to infection is high and the reparative power excellent. In doing this, however, sutures that must be retained until they leave external scars should be taboo. In some places adhesive plaster or some other external adherent will give results that are acceptable at least for the time being. The walls of deep cuts can be built up by buried sutures of the very finest silk, or chromic gut sutures; the ends of the latter are left protruding so that the knot can be thrown off later. The skin is closed by a subcuticular suture or a not too tightly placed skin suture that can be removed in 2 days.

Fig. 30. Tattoo, powder marks. Left, part of a face that was widely peppered by deeply penetrating grains of burning black powder. At right, after the last of three operative steps of removing each separate grain and the discolored tissue, with a sharp-pointed cataract knife, and suturing each separate minute wound. The earlier this is done the more will be accomplished. There may be other worth while ways of handling these, but we have not yet found them.

*Indications for immediate suture.* Trap-door flaps cut with beveled edges, if clean-cut, should be immediately sutured in place. When seen later after the scar has drawn the flap back into place, it presents a humped-up pad of flesh surrounded by a wide surface scar, the whole being very difficult of correction. This is due to two things. Much of the thin edge of epithelium covered derma has shrunk and crumpled until it is unusable, and in healing, the unrestrained sheet of scar that cements down the flap has later contracted, giving the cushion form to the overlying tissues. The fact that the trap door was beveled and not of uniform thickness makes the second raising and trimming quite wasteful. On the other hand, these have usually been cleanly sliced with sharp edged glass and are particularly well adapted to primary suture. It might be possible to place 2 superimposed rows of buried triple 0 white silk interrupted sutures, the deeper row being subdermal on the flap side

and catching the deeper edge of the derma opposite. This should cause the thin edge of the flap slightly to override. More accurate adjustment of this overlapping edge might be attained by fine interrupted silk or horsehair sutures to be removed in 48 hours at most. The cleansing should be thorough, all black oil and dirt likely to produce a tattoo being removed and a firm pressure dressing applied, possibly with the help of a drain when needed, to prevent the accumulation of ooze under the flap. The drain must not be bulky; a fine strip of thin rubber tissue or a rubber band should suffice. When there is any doubt about the blood supply, then one is content to steady the flap in place with a very few deep tacking sutures (Fig. 28) and to apply gentle pressure. Fixation with elastic compressors may be attained either with a slightly elastic bandage or a patch of elastic cloth connected with adhesive.

This mandate for immediate suture also holds for three other types of injuries:

1. The first includes cuts into or through the substance of the ear, especially when a large fragment remains attached by only a narrow pedicle. Here a limited amount of trimming of the skin or cartilage borders to insure primary union is often advisable, for it is not unlikely that even more would be lost in preparation for a secondary closure. The sutures should be so distributed as to allow for drainage of serum and blood. Distortions or collapse of the external ear canal should be immediately corrected and the lumen slightly distended with gauze or cotton. A loss of skin lining might be immediately replaced by a split free skin graft.

Subcutaneous hematoma should be removed or prevented by drainage incision and any break in the cartilage should be adjusted with fine silk sutures, fixed with a pressure dressing. As pointed out by Davis, a damp, soft marine "carriage" or "bath" sponge[1] will, under gentle pressure of the dressing, conform to all of the creases and convolutions of the ear, and makes an excellent splint.

[1]A good quality of Mediterranean sponge known to the trade as "sheep's wool" is excellent for this purpose. Of late years we have been getting an equally good Florida sponge, which is quite a bit less expensive. These sponges are prepared by thorough washings and repeated rinsings in soft water, with about 1 in 2000 cyanide of mercury solution; they are then squeezed and dried, and stored dry as sterile.

2. Second, immediate suture is recommended for all narrow double surfaced flaps, as the border of a lip, an ear, or an eyelid, for if left hanging they are apt to become so distorted as to be beyond the possibility of use for later secondary sutures.

3. Third, all cuts or tears of the nose skin and its cartilage, including the septum, should be closed with sutures, accurately or approximately, wherever possible. This may be extremely difficult to accomplish later. In general, all wounds that look possible, circumstances permitting, should be approximated in such a way that permanent suture scars will not be left, but except in the above instances, no débridement should ever be done on face wounds beyond the trimming of shreds. Evidently contused tissue might be held in place by a few deep tacking sutures that do not include the skin. At best, in contused tissue, an attempt to do a primary skin suture is not apt to give a pleasing scar, the risk of suppuration and necrosis being increased. This does not mean, however, that the presence of a local area of contusion would necessarily preclude suture in other parts of the same wound.

*Other methods of treatment.* In extensive through-and-through cuts of the lip or cheek, the deep portions can be approximated by sutures, put in from the mucus surface, that engage all tissue except the skin; the latter can be treated as seems desirable. If this is not practical, raw surfaces can frequently be covered to advantage by tacking the mucosa to the subdermal tissues. This practice was particularly adapted during the War to treatment at forward stations of large wounds of the cheek or lip caused by "high explosive" fragments.

The tooth penetrations of the lip, so common in childhood, or other punctures, had best be allowed to heal spontaneously. The approximation of face wounds with adhesive plaster in such a manner as to permit needed drainage is least apt to do damage and can be done so as to be extremely helpful. The question of the usability of a totally detached fragment or feature will arise sometimes. The result of all such attempts on the face that have come to our notice has been failure,

but one might at times risk unending criticism by refusing the attempt. The Hindus are credited with replacing lost noses with tissue immediately transplanted from the buttock. I have seen one distal phalanx, completely severed proximal to the nail, carried to the hospital from quite a distance in a potato, that, after suture in place by Barrett Brown, not only lived, but united so smoothly that the scar line was practically invisible.

Brush burns from sliding contact with the street or pavement present their own special problem. If not deep and fairly free from grit, surface cocainization followed by weak tincture of iodine might foster the formation of a dry clean scab. If this is not suitable, apply simple wet or grease dressings until clean, or better still, circumstances permitting, first scrub the surface clean of grit. It is often not possible to remove all the imbedded material, especially road oil, but imbedded grit will usually be thrown off and oil tattoos can be dealt with later (Fig. 29). Deeply imbedded grains of black gunpowder can be immediately excised, grain by grain, with a pointed cataract knife which is sharp to its needle-like point, with or without suturing each minute wound (Fig. 30). Larger foreign bodies should be removed if possible at the time of the injury, but sometimes they can be entirely overlooked.

Bits of stick and even a piece of a pipestem have become lost in the faucial-palate tissue. These may be palpated, and should be removed when found. An errand boy in a steel mill carrying a short thin rod fell and exhibited a good deal of shock, but no wound was found. A few days later he died of a rather general sepsis and autopsy revealed that the rod had punctured the fold of the lid above the globe, and through the sphenoidal fissure, entered the middle lobe.

Deeply situated bullets, multiple shot, and metal fragments may demand nice decisions in regard to their removal.

Large clean cuts in the tongue or mucosa of the cheek might be immediately sutured, but no sutures should be put in the floor of the mouth unless free inferior drainage is provided, because of the possibility of spreading infection.

Motor nerves within the face are so thread-like that their suture is, I think, impractical, and they are here seldom completely destroyed. If Stenson's duct is cut, its repair had best be postponed until after the wound has healed and repair will then seldom be necessary.

Torn scalp flaps should be cleaned and sutured back in place if they still have a possible blood supply. If all or part of the scalp has been completely detached, the attempt to do split skin grafts directly on the periosteum immediately or after some cleansing effort might be quite justifiable.

Detrimental psychic reactions not infrequently follow deforming injuries. These should be watched for and, when present, combated with as much care as is bestowed upon the physical repair; if they are not overcome, the most perfect restoration may be utterly unappreciated.

## Discussion

DR. ROBERT H. IVY, Philadelphia: There is little to be said in discussion of Dr. Blair's paper, except that I agree with him in all the principles that he has laid down. In the application of these principles to individual cases, there are one or two points that might be discussed.

Every surgeon who attempts to treat cases of jaw fracture should master the technique of wiring the teeth. Modifications of the method first proposed by Gilmer have, I believe, improved it. The florist's iron wire is suitable in an emergency, but 24 gauge soft brass wire is most satisfactory, and there is no reason why every hospital should not have a supply of it. Silver wire is practically useless for the purpose, as it will not withstand twisting. Above all, do not use steel wire, as it is too hard to cut off the teeth. We do not advocate the direct wiring or suturing of the bone itself across a recent compound fracture of the mandible. This usually leads to suppuration around the wire, which is soon loosened and thrown off like any other foreign body in an infected field. There are other ways available for controlling the fragments, as described by Dr. Blair.

I heartily agree in regard to the slight value of roentgenologic examination in these cases as a check-up on union. The surgeon who relies chiefly on roentgenographic reports as to position of fragments in fractures of the mandible is likely to fall into grave

error. Far more reliable is clinical evidence as shown by the relationship of the lower to the upper teeth.

For reduction of fracture of the upper jaw, the reverse Kingsley arch, in connection with a plaster-of-paris head cap, is standard with us. An emergency arch of heavy wire can be kept on hand and adapted to fit almost any case, and then wired to the teeth.

For elevation of depressed fractures of the malar bone, we have tried practically all of the methods that have been advocated from time to time. We now use routinely the approach suggested by Gillies, introducing an angular elevator from above through a skin incision in the temporal region, the instrument passing down beneath the malar through a slit in the temporal fascia. This is usually extremely simple and requires about 5 minutes. It is possible that in an occasional case where there is marked comminution of the wall of the maxillary sinus, the approach through the mouth and introduction of a lever into the sinus might be better.

Dr. Warren B. Davis, Philadelphia: During the last three decades, Dr. Blair has given to surgery many original plans of treatment, both for congenital and acquired deformities of the face, supplemented by the selection and co-ordination of the best that could be gleaned from the world's foremost clinics. We are fortunate this evening, in having had him present this summary of his present opinions regarding the early local care of face injuries.

In securing the best functional and cosmetic results, the importance of the early care cannot be overestimated. The splendid blood supply to the facial structures makes reconstructive plastic surgery in this area surprisingly successful, provided the work is done by one who is thoroughly familiar with minute anatomic details, and has been trained to avoid adding further trauma to tissue already extensively injured. The basic principles which Dr. Blair has presented are being followed, in a large measure, in all of our better maxillofacial clinics, there being only the differences in some details, which are the variations, modifications, and some minor additions which naturally develop as personal elements in any type of surgical work.

The importance, in most cases, of bringing fractured facial bones into the best possible position soon after injury cannot be overestimated. In some fractures involving the ethmoidal area, and in comminuted fractures of the anterior walls of the maxillary sinuses, a delay of a few days may be preferable. Meticulous care in keeping the nasal and paranasal areas cleansed not only promotes more rapid healing, but greatly decreases the dangers from meningitis and later from chronic infections in the sinus areas.

In those nasal injuries occurring in childhood, which are not necessarily extensive but which so often show increasing deformity during adolescence, we believe that the deficiency in the development of the septal cartilage is often the result of a low grade infection occurring in septal hematomas. These deformities would, in a large measure, be prevented by an incision, allowing the blood clot to be removed, or the abscess to be drained promptly if infection occurred.

Dr. Blair does not regard nasal packs of value in nasal fractures, except in cases of fracture of the septum. I am sure, however, that vaselinized gauze packs, carefully applied and changed at 24 hour intervals, have often been of definite value in our cases, in giving adequate support to the bony nasal structures, after the correction of depressed fractures.

Injuries to the soft tissues are benefited and rapid healing is promoted by the frequent application of warm moist compresses by day, and during the hours for the patient's sleep, the liberal application of plain dionol, or else plain sterile vaseline. By such care, tissues which are badly traumatized can often be saved, and disfigurements correspondingly minimized.

The majority of our maxillofacial surgeons are rendering good service in the correction of these traumatic deformities, but much remains to be done in prophylactic measures. Our major industries have accomplished much by the institution of safety measures and better training of their workmen, but the crying need of our day calls for unification of state and national traffic regulations and real enforcement of the laws pertaining to them.

# CONFERENCE ON TRAUMATIC SURGERY

## INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FREDERIC A. BESLEY, M.D., F.A.C.S., Waukegan, Illinois

THE ever increasing interest of the industrialists of the United States in the health welfare of their employees is most gratifying and satisfactory.

The fellows of the American College of Surgeons may be pardoned if they seem justly proud of the part they have played in creating and maintaining this interest. Industrialists are coming to a point of understanding the fundamentals involved. There is no conflict of interest. A financial gain accrues to the employer in every advance made in the health welfare of the employees. The employer is coming to see this. The healthy employee is much more apt to be contented as well as more efficient. His earning capacity is greater and he is therefore much less prone to indulge in controversy and strife.

May I here pay my personal tribute to that splendid group of men known as industrial physicians and surgeons who have done so much for the health welfare of the workers in industry. They were pioneers in this field of medicine which is becoming a more and more important activity in our endeavors to render a service to society. These men, as pioneers, were exposed to a good deal of unjust criticism in their early efforts due to a misunderstanding on the part of the general profession. Fortunately this attitude is passing rapidly and the importance of the work of these physicians and surgeons in industry is receiving deserved recognition.

The new state compensation laws, which are made to include industrial diseases as well as mechanical injuries, add another financial responsibility for the employer.

These new laws in states where compensation for industrial diseases was not involved previously will necessitate a further interest on the part of the employer in the prevention of diseases and the care of such cases when they occur. This situation seems to us to be desirable.

In this connection it becomes incumbent upon all physicians and surgeons interested in industrial medicine and traumatic surgery to advance every educational facility that will add to our knowledge of the art and science of these subjects.

The American College of Surgeons has in the past, and will continue in the future, to promote every educational method for a broader understanding of this relationship between employer and employees as it pertains to the health welfare of the workers.

Our associates in the American College of Surgeons who are working in the field have communicated with 1,600 industrial institutions and have made an intimate first hand survey of that many medical departments; 800 have been approved as meeting our minimum standard requirements. In this field of endeavor a great deal of educational material has been conveyed to industrialists who have in large part assimilated this information and are rapidly putting into effect the suggestions that have been made; they show every indication of being willing to conform to our minimum standard. We are certain that if this standard is established, they will continuously comply with its principles and accept suggestions for further advancement and improvement.

The ready and cordial co-operation on the part of the leaders among the employers in the raising of the whole trend and character of their medical departments has been one of the most gratifying phases of our entire program. It makes a continuance of our work practical and possible and this attitude on the part of the medical men in industry and their executives is inspirational, stimulating your committee to renewed activity.

The large problem of pneumonomycosis or pulmonary fibrosis due to irritating dusts is still abroad in the land and is worthy of prolonged discussion and serious consideration.

New problems will continue to arise. Industrialists are rapidly coming to recognize the American College of Surgeons as a group of men who are the leaders in the thought for better medicine and surgery in industry, upon whom they can rely for disinterested advice and guidance in the development of their medical departments.

That we may be prepared to assume and meet these responsibilities, it is necessary that we give

Chairman's address presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

profound consideration to every phase of the situation. Our own knowledge must be broadened so that we may be better fitted to meet our growing obligations in arranging for a higher standard of medical and surgical service to the workers in industry.

It should be our purpose to promote this activity of the College, through the Committee on Industrial Medicine and Traumatic Surgery, until our achievements are comparable to the great work of the Department of Hospital Standardization.

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# TREATMENT OF ABDOMINAL TRAUMA

ARTHUR R. METZ, M.D., F.A.C.S., RAYMOND HOUSEHOLDER, M.D., and JAMES F. DE PREE, M.D., Chicago, Illinois

THE surgeon on whom rests the responsibility of the care of injured employees of any industry should have in effect certain rules and regulations pertaining to the care of the injured, from the time the accident happens until the patient is brought to the hospital where active surgical care is to be given.

The simplest rule governing the care of an employee after any accident is to make it compulsory for the injured to be taken at once to a designated first aid station or hospital, so that he can be carefully examined and his treatment directed. It is important that all officials connected with the industry, from the higher officials down to the section or gang foremen, see that these instructions are promptly carried out, so as to avoid the embarrassment of overlooking a major injury which did not appear to be of much importance in the beginning. This applies particularly to abdominal injuries.

A strict rule of one of our large railroads is to get the injured to the hospital, with the least possible disturbance, immediately after any accident has occurred. In most cases, the injured should be at his designated first aid station or hospital in less than 1 hour from the time of the accident.

An example of lack of such co-operation recently came to our attention. A section man prying on a piece of track with a crow bar, which he was accustomed to using, suddenly let the bar slip so that it struck him in the abdomen with some force. The employee realized that he had received a hard blow as a result of his own efforts and carelessness and made no complaint of the injury at the time. Because he minimized his discomfort, his fellow workmen gave it no concern. He continued to work for about 1 hour until quitting time, after which he started home. After he had walked some distance he was overtaken by a fellow workman in an automobile, who noticed that the man appeared to be sick and at once put him in his car and took him home. The same evening, approximately 5 or 6 hours after the accident, his family physician was called. The patient was then taken to a hospital where a consultation was held, and, approximately 8 hours after the accident, it was decided to operate. At operation a rupture of the small bowel was found. The patient died of general peritonitis 2 days later.

Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

It is repeated examples of this type that make it essential that the company surgeon have in effect pre-existing rules, which are to be followed by all employees, gang foremen, and safety departments in case of accidents.

At present we are concerned with the treatment of trauma to the abdomen, and have in mind the injuries in which the diagnosis is doubtful in the beginning, and the cases that require some observation in order to determine the extent of the injury and the indicated treatment.

*Mechanism of injury.* Trauma to the abdomen can be of many different types. The most common causes are as follows:

1. Direct blow to the abdomen by some blunt object, such as a piece of wood or tool which the workman is using.

2. A fall from a height of a few feet or more, the impact of landing producing injury.

3. Injuries resulting from stab or gunshot wounds.

4. Squeezing injuries, such as are caused by being caught between moving objects.

*Anatomy.* In considering trauma to the abdomen the surgeon must keep in mind the anatomical structures which constitute the abdominal area. This area consists of the abdominal wall which is supported by the ribs and spine and is anchored to a bony framework at the lower por-

tion consisting of the pelvis. Within the abdomen is contained the hollow viscera, consisting of the gastro-intestinal tract, the urinary bladder, and the gallbladder. The solid structures which are prone to injury are the liver, spleen, kidneys, and pancreas. The supports of the abdominal organs are more or less elastic and contain blood vessels which may be injured so that fatal hemorrhage results.

*Symptoms.* It is logical to expect that some symptoms are present after any injury, depending upon the amount of damage done. Their importance and the extent to which complaint will be made varies a great deal with the individual. It is known that some patients will endure pain and belittle symptoms after an accident, especially if it is the result of their own carelessness. Other employees are prone to exaggerate minor symptoms, purely for sympathy and to avoid work, which may result in misleading the examining doctor.

Bearing in mind these variations, it is a test of the examining surgeon's diagnostic ability to determine the true value of the complaints and physical findings. The common complaints following an abdominal injury are pain, weakness, and thirst.

*Examination.* 1. When the patient is first seen, particular attention should be given to the degree of shock, the volume and rate of the pulse, blood pressure, temperature, and respirations being noted.

2. On physical examination, careful inspection should be made to notice any external evidence of injury, such as swelling, abrasions, or areas of redness; to determine if any fractures are present about the pelvis, spine, or ribs; by palpation of the abdomen, to determine if there are any local points of tenderness or muscular resistance. Areas of dullness or tympany should be noted. It is well to mark off such areas with a pencil, so that they can be easily checked at future examinations.

3. A complete blood count should be made.

4. Urinalysis, with examination for presence of blood, should be made.

5. Roentgenograms showing the entire abdomen, including the pelvis and lower chest, should be taken. In some cases it is well to take lateral views to look for areas of gas that may be free in the abdomen.

6. An accurate history and description of the mechanism of injury should be obtained to determine the amount of violence, the distance of the fall, or any other factors that may be of value in determining the possible severity of the injury. The patient's reaction immediately following the accident should be ascertained—whether he noticed a sudden, sharp pain, whether he had to sit down or stop work for a short period of time, or whether he was immediately rendered unconscious. This information may have important bearing in helping to determine the extent of the injury and in arriving at a diagnosis. In addition, it may be very valuable for future reference, as stories of accidents frequently change after time has elapsed.

### TREATMENT

If, after noting the above conditions, the extent of injury is not evident, the patient should be put to bed for observation. Repeated examinations should be made at least every 30 minutes until a positive diagnosis is reached. It is advisable to avoid sedative drugs, such as morphine, during the period of observation as they tend to mask important symptoms.

When shock is present it should be promptly treated. The simplest treatment consists of applying heat to the body, by means of hot water bottles and warm blankets, and elevating the foot of the bed 12 to 15 inches. If the pulse is weak and there is evidence of hemorrhage, 700 to 1,000 cubic centimeters of 5 per cent glucose in normal saline solution should be given intravenously. We almost never consider the use of blood transfusions.

The surgeon should make a positive diagnosis of intra-abdominal injury within less than 6 hours from the time of the accident, preferably within 2 to 4 hours, if possible. A patient operated upon within 6 hours, as a rule, has a good chance for recovery; after 6 hours the chance of recovery greatly diminishes.

In perforating injuries to the abdomen, such as gunshot or stab wounds, it is apparent that the abdominal wall has been pierced so that immediate operation to repair the defects should be performed. This type of injury is usually evident and need cause no delay in making a diagnosis and deciding the treatment.

Squeezing injuries to the abdomen may result in injury to the hollow organs, such as the gastrointestinal tract or urinary bladder, or may rupture blood vessels causing dangerous hemorrhage, and, in addition, may produce fractures of the solid structures, such as the liver, spleen, kidneys, or pancreas.

A severe squeezing injury through the upper abdomen recently came under our observation, the patient having been caught between a truck and the sill of a box car. The injury was severe enough to cause the patient to sit down for about 20 minutes, after which he felt improved and con-

tinued walking about; he reported the injury to his fellow workmen. This man was employed on a railroad which enforces a strict rule that any man receiving an injury report for a medical examination; therefore he was at once taken to a first aid station. After being examined, the patient wanted to go home, but the doctor at the first aid station insisted that he go to the hospital for roentgenograms and observation. This was promptly done and he arrived at the hospital in less than an hour from the time of the accident. On first examination no objective signs of injury could be found, but the patient complained of pain in the upper abdomen. He was at once put to bed for observation and a blood count made which showed 20,000 leucocytes. The blood count was rechecked in 30 minutes and showed that the leucocytes had increased to 22,000. During this time there developed a definite rigidity in the upper abdomen and it was decided that the patient had a surgical condition which should be treated by operation. The patient reluctantly consented to operation. He was given morphine, scopolamine, and ether anesthesia and was operated upon within 4 hours from the time of the accident. When the abdomen was opened a rupture 2 centimeters in diameter was found on the anterior surface of the stomach 4 centimeters proximal to the pylorus. The perforation was closed and foreign material consisting of 6 raisins and portions of raisin cake was removed by suction. In addition, there was a definite retroperitoneal hematoma which was not disturbed. The abdomen was closed with drainage. The patient made a good recovery and returned to his usual work.

This case is mentioned to illustrate that, without the co-operation of fellow workmen and competent first aid observation, operation in this case might easily have been delayed 8 to 10 hours; at the end of that time the end-result might have been different.

Injuries to the liver and spleen may be treated conservatively if we can be reasonably sure that the patient is not developing a serious hemorrhage, which will be evident by a rapid and weak pulse, subnormal temperature, and a marked pallor. With evidence of hemorrhage it is essential to open the abdomen and control the source of bleeding. A ruptured spleen can be safely removed with no after effects. We have never tried to suture the spleen but have removed it when necessary. In our experience, rupture of the liver has been a very rare complication of abdominal trauma. Injuries to the liver can best be managed by resorting to a pack or sutures.

Injuries to the kidneys are fairly common complications of abdominal trauma and are best treated in a conservative way. Hematuria, the most prominent symptom in renal injuries, is usually present from the onset and may persist for 1 to 2 weeks. Associated with the hematuria is pain in the back which increases in severity so as to require sedatives. There is also a moderate degree of shock present in most cases. A careful check on the blood picture at intervals of 1 to 2 hours, as a rule, will give an indication as to the extent and severity of the injury. It is also important to keep a close observation on the blood pressure. If the patient's general condition goes along in a satisfactory manner, conservative and supportive management is indicated, although the use of drainage in the loin may be necessary later. If the patient's condition appears critical, it may be necessary to explore the kidney area so as to control hemorrhage and institute drainage. In some cases it is necessary to do a prompt nephrectomy or resort to a pack.

A rupture of the bladder can be anticipated in injuries about the pelvis, especially if fracture is present. The urine should be examined for presence of blood. Additional investigation should be made by injecting a known amount of solution into the bladder and by being able to withdraw a like amount. If evidence of rupture is found, prompt repair is necessary.

## CONCLUSIONS

The following points should be observed:

1. Prompt transportation of the injured to a company surgeon, or hospital, as soon as possible after any accident, however minor it may appear.
2. Careful history as to mechanism and severity of injury.
3. Examination of the injured with making of records and prompt laboratory procedures; repeated examinations at frequent intervals, at least every 30 minutes, until a surgical opinion has been reached.
4. Operation, when indicated, within the first 6 hours, if possible. It is better to operate in cases which present indefinite and obscure findings with the possibility of serious abdominal injury, than to consider conservative observation too long. Patients operated upon within the first 6 hours have a better chance for recovery than those upon whom operation is delayed.

# THE TREATMENT OF OLD TRAUMATIC BONY LESIONS OF THE FACE

ARCHIBALD H. McINDOE, M.Sc. (Path.), M.S., F.A.C.S., F.R.C.S., London, England

IT is a matter for common observation that accidents which cause extensive injury to the bones of the face are so often responsible for serious injuries elsewhere that the facial deformity must of necessity be neglected in the general effort to save the patient's life. For this reason many complicated fractures of the facial bones are allowed to heal in bad position and are brought to the surgeon's attention only when they are so consolidated that satisfactory treatment is a matter of great difficulty. On the other hand, many of the simpler types of fracture which could easily be rectified immediately are masked by local swelling which rapidly follows any severe blow on the face, so that both patient and physician may be unaware of the presence of a fracture. With the subsidence of edema, a definite deformity of contour is revealed, usually at a time when simple manipulation fails to restore the parts to normal. Unquestionably many such old healed fractures with gross displacement cause little or no disability other than that which might be called esthetic, but with the changing values in the world of today, few would dispute the right of the disfigured patient to have, as far as possible, the evidence of his deformity obliterated.

It has been my experience that the more serious of these malunited fractures are extremely difficult to treat and entail considerable fortitude on the part of the patient and not a little courage on the part of the surgeon. Nevertheless, I hope to show you that the effort is well justified and that much may be accomplished long after the deformity has become firmly established.

The three general principles which should guide one in the treatment of these lesions may be simply expressed as replacement of displaced bone when this is advisable or possible, substitution of bone or cartilage for bone loss, and finally, camouflage of the deformity resulting from the fracture where replacement or substitution is impossible or impracticable. The course adopted in any particular case will depend on a variety of factors, those chiefly concerned being the general condition of the patient, age, sex, and status in life, and the extent of the injury as revealed by most careful roentgenographic examination. It might be pointed out here that the ordinary frontal and lateral plates of the skull give little help in showing the actual position of the bones in facial fractures. The supero-inferior, the 30 degree occipitomental, and the use of small dental films, however, give one positive information about the position of the fracture lines.

In this communication I propose to discuss the treatment of old fracture deformities of the face above the level of the lower jaw, and among those bones I have arbitrarily included the frontals. They fall into five groups:

1. Fracture deformities of the frontal bones.
2. Fracture deformities of the nasal bones.
3. Fracture deformities of the malar zygomatic compound.
4. Fracture deformities of the nasal ethmoid maxillary compound.
5. Fracture deformities of the malar maxillary compound.

## FRACTURE DEFORMITIES OF THE FRONTAL BONES

Old symptomless depressed fractures of the frontal bones which have not been satisfactorily elevated at the time of the accident should be let alone unless the depression is limited to the outer wall of the frontal sinus. In this case it is worth while to expose the outer wall of the sinus through such scars as happen to be present, and after inserting a lever into the sinus, to force the outer wall forwards into correct alinement. It is probably safer, however, to conceal all frontal depressions without bone loss by the insertion of a fat cartilage or muscle graft into the hollow, and so build out the contour of the forehead. Before this is done all forehead scars should be neatly excised and resutured, and great care taken to see that the frontal sinuses are free of infection. At least 6 months should elapse between the final disappearance of infection and the insertion of the graft. The fat graft, taken from the abdomen or thigh, and preferably from the site of an old scar, should be inserted through a small incision, through

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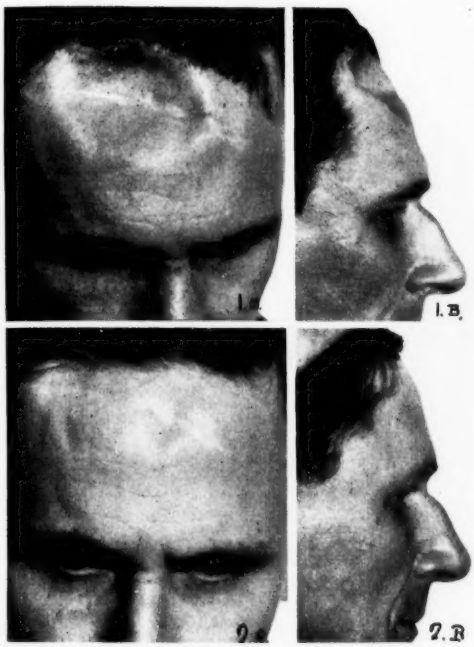


Fig. 1. 1a, 1b, Fracture deformity of frontal bone. 2a, 2b, Result of iliac bone graft with fat graft superimposed.

Fig. 2. 1a, 1b, Fracture deformity of frontal bone. 2a, 2b, Result of insertion of cartilage graft.

which with a slender pair of scissors the skin covering of the entire depressed area has been carefully undermined. Sufficient fat to overcorrect the deformity by 30 to 40 degrees is required to obtain a normal contour in 6 to 12 months. Excision of extensive scars and coincident insertion of fat for the correction of a deformity of contour is somewhat hazardous owing to the high risk of sepsis which is liable to follow the latter procedure, particularly if much fat is used. It may be taken as a good rule always to insert a fat or muscle graft as a separate operation, through a small incision and with the strictest aseptic precautions.

Bony losses of the supra-orbital ridge, which often include the external angular process of the frontal and the frontal processes of the malar, result in a marked flattening of the eyebrow and produce a curiously dead appearance to the eye. Fat or cartilage grafting again give a reasonably good result, though a bone graft from the crest of the ilium, carved to shape and fixed in place with catgut or wire, is superior in that it gives a more pronounced ridge, at the level of the eyebrow, which will not shrink like fat and will therefore be more likely finally to resemble the opposite side. Fat may, of course, be added above, if necessary, to fill any further hollow.

Loss of substance of the frontal bones above the level of the frontal sinuses is usually responsible for considerable external deformity and, like defects of the calvaria elsewhere, demands some form of hard tissue replacement, both as a protection to the exposed brain and as a means of filling the pulsating hollow. The introduction of artificial substances, such as celluloid or gold and silver plates, into these gaps may be mentioned only to be condemned. In general one may divide these bony defects into those which are circular or oval in shape and those which are long and narrow. They correspond roughly to the shape of the object with which the forehead is brought violently in contact. A variety of grafts have been used in the closure of these losses, but I have found two methods of great value. For the circular defect a most satisfactory source for a bone plate is the inner aspect of the iliac bone. After medial displacement of all the soft tissues

Fig. 3. a, Old lateral nasal fracture with displacement of bones to left. No displacement of tip. b, Nasal refracture, comminution, and resetting with manipulation of septum.

Fig. 4. a, Old lateral nasal fracture with displacement to the left. Multiple dirt ingrained scars. b, Nasal refracture, comminution, and resetting with excision and resuture of scars.

attached to the crest of the ilium and inner surface of the body, the inner compact layer can be chiselled off over a wide area. The plate of bone is cut exactly to fit the exposed defect; it will be found that the natural configuration of the bone is such that the smooth concave inner surface fits neatly next to the fibrous layer overlying the dura, while the convex outer surface adapts itself to the external contour of the forehead. The graft is "stepped" into the edges of the defect and oversewed from side to side with chromic catgut or wired into place (Fig. 1). Long narrow defects can be similarly filled with a strip of the iliac crest, though I have found a solid piece of cartilage from the seventh rib rather easier to cut and fit into place (Fig. 2). Certainly the result is as stable and satisfactory. If the contour of the forehead is not finally satisfactory, a fat graft can be inserted over the bone or cartilage graft 6 months later.

### FRACTURE DEFORMITIES OF NASAL BONES

In contradistinction to the frontal bones, in which replacement is rarely possible and where any such attempt should await thorough healing of the parts and then largely consist of substitution or camouflage, the nasal bones when fractured and displaced should be attacked as soon as possible after the injury. In the first 3 weeks manipulation is sufficient, but after this time a much more radical procedure is necessary. With the passage of months or years the problem becomes even more difficult because the malposition of the bony structure is invariably accompanied by a permanent distortion, dislocation, deviation, or total crumpling or loss of the septum with secondary defects of the alar and lateral cartilages which effectually prevent straightening, even with the most thorough bony mobilization and disimpaction of the bones.

From the diagnostic standpoint we may therefore recognize two distinct types of old nasal fracture, each requiring different treatment:

1. Lateral fracture, due to a blow from one side or the other results in more or less marked lateral displacement of the nose and the cartilaginous septum, but without loss of bridge line contour. The frontal processes of the maxillæ are fractured at their bases and at their junction with the nasal and frontal bones, one being displaced inward and the other outward, both rotating on their fractured bases. The nasal bones themselves are usually comminuted, separated from their attachments, and rotated in the direction of the fracturing force. Overlapping impaction of the nasal bones into the nasal processes of the maxillæ is not uncommon. The septum is displaced and bent away from the side struck, producing obstruction to the nasal airway on that side. The lower part of the septum may be dislocated from the nasal crest.

2. Old telescoping nasal fractures, due to a severe blow received directly on the nose from in front or below, are those in which the nasal bones, usually badly comminuted, are forced bodily between the nasal processes of the maxillæ which are splayed out to receive them. The bridge is thereby flattened and widened. The septum is displaced; sometimes it is bent double so that the upper half lies transversely in the nose, producing more or less complete obstruction on one side or the other. Dislocation of the septum at its upper border is not infrequent. Still more commonly there is considerable cartilaginous loss due to old infected hematoma so that all that remains of the septum is a crumpled mass of cartilage lying in the floor of the nose. Complete collapse of the bridge line results. There are, of course, mix-

Fig. 5. a, b, Old lateral nasal fracture with marked deviation of entire nose to left. c, d, Λ-shaped osteotomy, right frontal maxillary process, with refracture of nasal bones and resetting. Modified submucous resection with shortening of nose.

Fig. 6. a, b, Marked displacement of nasal bones to right, septum to left. Right sided obstruction, 10 years' duration. c, d, Refracture, comminution, and resetting after modified submucous resection.

tures of the above types, containing elements common to both.

By the time these fractures have consolidated, which they rapidly do with great firmness, the problem is usually complicated by the fact that bony replacement will fail to produce a straight nose unless the septum is dealt with either at the same time or as a preliminary operation. Occasionally in the more moderate and recent degrees of crookedness, and before the septal deviation has become a permanent deformity, it may snap back into position after bony replacement. In general, however, failure to deal sufficiently radically with the coincident septal displacement is the commonest cause of disappointment after bony replacement. (Figs. 2–9.)

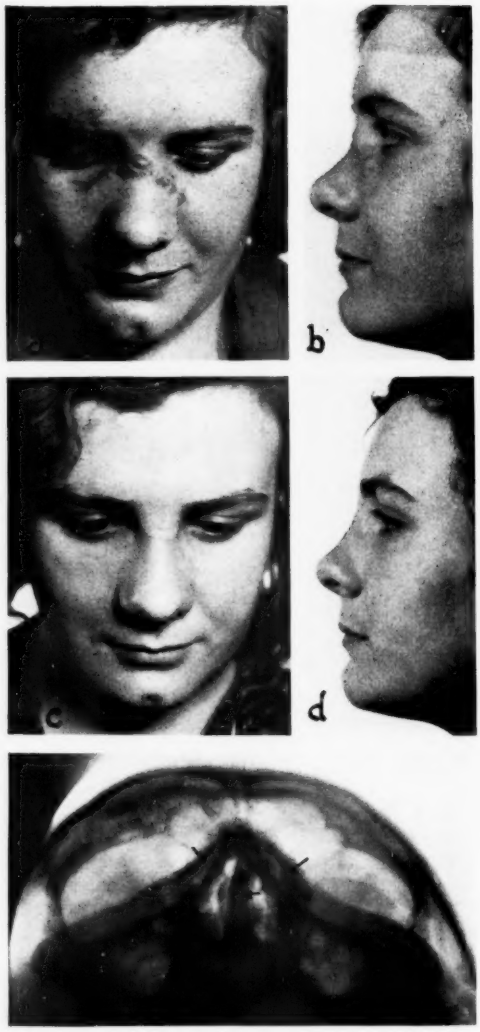
*Treatment of old fractures with lateral displacement.* With a moderate degree of lateral displacement, stab incisions are made in the lateral vestibular walls and a thorough subperiosteal elevation of the soft tissues from the underlying bones is carried out. Guided by the roentgen rays, search is then made for the old fracture lines, and these are cut through with a small nasal saw or a small chisel, or an osteotome of the French pattern, until the original fracture is reproduced as far as possible. Mobilization and disimpaction of the fragments by means of Walsham's forceps is then possible. With Ashe's septum forceps an attempt is then made to centralize the septum, which may return to its normal position when the overlying roof has been mobilized.

In the more severe types of lateral displacement, comminution of the nasal fragments must be much more radical, while in extreme cases in which the rotation impaction has produced a lateral bony wall much shorter on one side than the other, Λ-shaped osteotomy of the longer side through the nasal processes of the maxilla is necessary to allow the nasal arch to be centralized. The comminuted bones are splinted by means of a reinforced Stent's mold, a nasal splint of any preferred pattern, or, most simply and effectively, by two through-and-through mattress sutures of silkworm gut inserted through the fracture lines and tied over dental rolls of cotton, one for each

Fig. 7. a, b, Result of depressed nasal fracture. c, d, Result of mobilization of nasal bones.

side of the nose. The dental rolls are hardened by soaking in Whitehead's varnish.

The treatment of the septum is often a matter of opportunism, for by judicious submucous cutting of the cartilage at bent, adherent, or dislocated points, it is occasionally possible to swing it clear, into a central position, with both a good airway and a straight bridge line. If the septal displacement is marked and has existed for a long period, and particularly if it is associated with lateral deviation of the tip of the nose and nasal obstruction, an extensive submucous resection must be performed before the bones are refractured. The "bowsprit" left to support the bridge is mobilized sufficiently to allow it to swing centrally. If some degree of subsidence occurs or the upper edge of the bowsprit is still crooked, a septal graft cut from the piece removed may be inserted beneath the skin of the bridge through a split columellar incision to camouflage the septal defect. Refracture may then be proceeded with.




8. Fig. a, b, Impacted depressed fracture of nasal bones with scars; 6 months' duration. c, d, Excision of facial scars followed 6 months later by straight iliac bone graft to nose. e, below, Impacted depressed fracture of nasal bones with splaying of frontal processes of maxillæ and deflection of septum.

Occasionally the septal deviation is so extreme that nothing short of a total submucous resection, together with removal or correction of deformed alar cartilages, is sufficient. The resultant defect in the bridge line is subsequently remedied by a hinged costal cartilage or iliac bone graft.

Fig. 9. a, b, Impacted depressed fracture of nasal bones. c, d, Result of insertion of hinged costal cartilage graft.

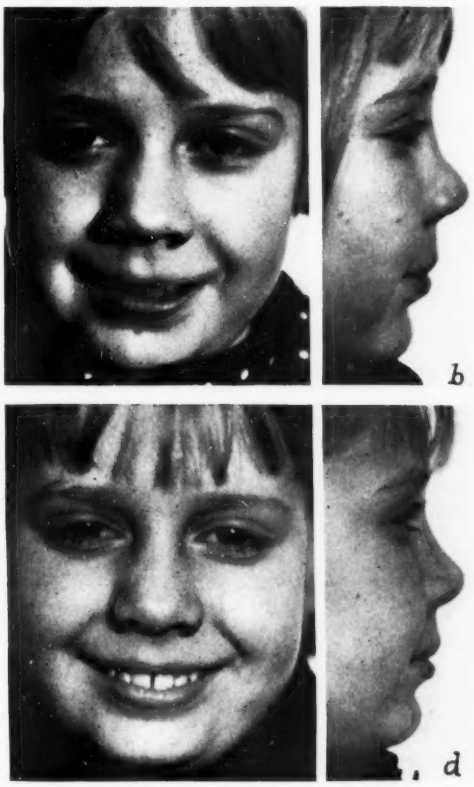
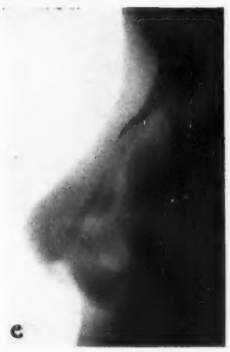



Fig. 10. a, b, Impacted depressed fracture of nasal bones in a child. c, d, Result after hinged osteochondral iliac graft. e, Roentgenogram of nose showing bony part of iliac graft.




*Treatment of old depressed nasal fractures.* It must be admitted that the attempt to reduce old telescoped fractures of the nasal bones by the refracture and comminution method and thereby obtain a normal nasal contour usually fails, although occasionally one may be successful (Fig. 3). The best that can be hoped for is a reduction in the marked splaying of the maxillary nasal processes by sawing or chiselling through their bases, and infracturing them after periosteal elevation. At the same time any septal deformity should be remedied as before. This prepares the ground for the insertion 3 to 6 months later of a supportive graft of bone or cartilage to correct the nasal contour. The type of supportive graft chosen depends upon certain factors. In children under 13 I prefer either a hinged osteochondral graft from the crest of the ilium (as the crest of the ilium is cartilaginous up to that age), or a straight costochondral graft from the seventh rib. The former is easily cut and shaped, and in addition to its cartilaginous body can include a thin layer of bone on the under surface which serves to keep the graft from twisting. Twisting is the most common difficulty with the purely cartilaginous graft. The costochondral graft consists of half an inch each of bone and cartilage cut from the costochondral junction of the seventh rib. When split longitudinally the bony portion of sectioned

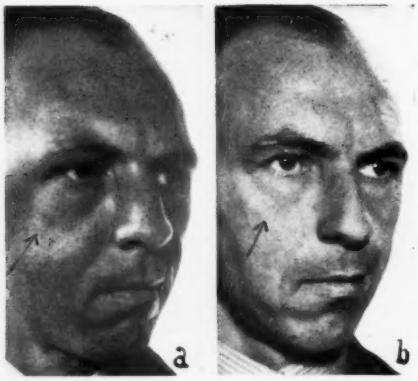



Fig. 11. a, Simple old malar fracture showing flattened right cheek. b, The same after malar replacement. Contour of cheek restored.

rib can be splayed outward until it resembles the missing nasal arch, while the cartilaginous portion replaces the missing septum. The bone and cartilage being joined through the medium of a growing center, this type of graft may conceivably grow *pari passu* with the child (Fig. 10). In adults I have found either a straight or hinged bone graft from the crest of the ilium more satisfactory than the costal cartilage type chiefly because of the certainty that the graft will remain straight.

### FRACTURE DEFORMITIES OF THE MALAR ZYGOMATIC COMPOUND

Like the nasal bones, the malar bone is peculiarly liable to fracture displacement which passes unnoticed until the swelling has subsided and the early and simple replacement is converted into the late and difficult one. Consolidation is rapid and it is likewise so firm that easy reposition by any simple method cannot often be successfully applied. The anatomic structure of the bone with its strong body and weak frontal, orbital, maxillary, and zygomatic supports, together with its susceptibility to blows from divergent angles, produces great variation in the situation of the fracture lines, and the resultant displacement differs in almost every case. Thus blows from in front produce fracture of some or all of the four points of support and depression of the body by crushing it into the fragile underlying anterior wall of the antrum. Tangential violence produces sliding, rotation, or tilting through a considerable arc, usually with the zygoma as a base. The external deformity is thus of a protean character, but always entails an inequality of the two malar

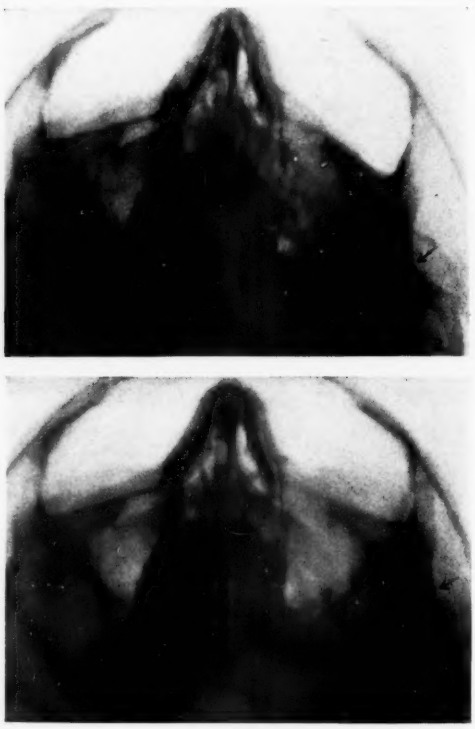


Fig. 12. a, Occipitomental view of case in Figure 11, showing fracture of right malar zygomatic. b, Same after replacement.

prominences with marked depression of the injured side. Clinical examination should include simultaneous comparison of the zygomatic arches, the frontal processes, the infra-orbital margins, and the upper buccal sulci on both sides, while careful roentgenographic examination, particularly in the occipitomental position, should never be omitted (Figs. 11 and 12).

The treatment of these fractures by replacement largely depends upon an accurate diagnosis of the extent and position of the old fracture lines, and it has been my experience that the more carefully this is done the more successful one will be. Leverage or wrenching will not elevate a firmly impacted and malunited malar unless the points of malunion are first of all located and methodically divided with the chisel and hammer. Simple malunited fractures of the zygoma itself are approached through the temporal route as described by Gillies, Kilner, and Stone, the fracture carefully felt for and divided by a slender

Fig. 13. a, above, Old fracture of infra-orbital (malar) margin with loss of substance. b, Result after temporal muscle flap operation.

Fig. 14. a, Nasal ethmoid maxillary fracture with telescoping of nose. b, Treatment by insertion of massive iliac bone graft.

osteotome. Leverage with the special malar lever then allows the arch to bow outward to a normal position. More extensive impacted malar fractures with displacement of the body require a double or triple approach, utilized in the order described. The first is the temporal approach, a lever being slipped down behind the temporal fascia to gain a purchase behind the zygoma and the body of the malar. Through this incision various bony attachments about the zygoma and frontal process can be felt for and attacked with the chisel. The second is the buccal approach, through the canine fossa. Subperiosteal elevation of the soft parts from the anterior surface of the maxilla reveals the malar maxillary articulation and the crushed in anterior antral wall. As a rule a second lever can be passed directly into the antrum to obtain leverage behind the malar maxillary articulation. At the same time bony adhesions of the processes to the body of the maxilla are divided. The third or infra-orbital approach is utilized only if mobilization by the

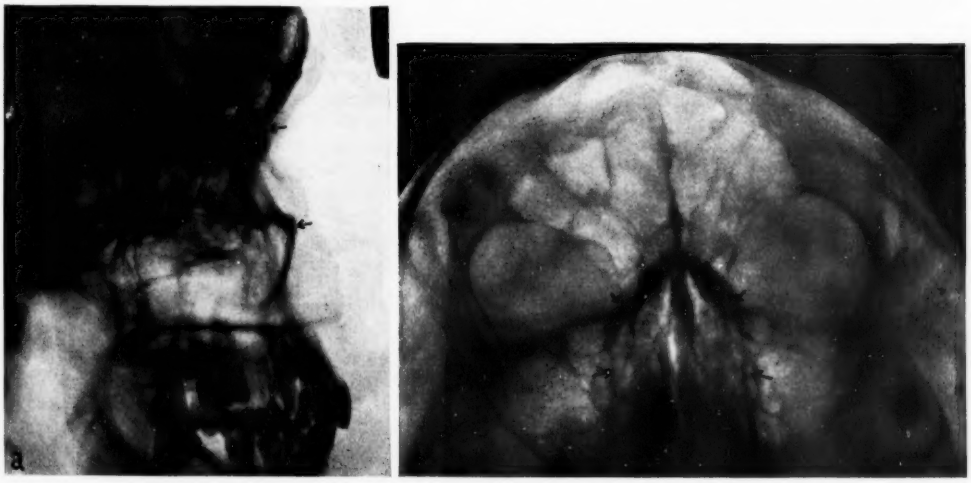



Fig. 15. a, Impacted fracture of nasal ethmoid maxillary compound. Lateral view showing bony block crushed into ethmoid sinuses without fracture of cribriform plate or retrodisplacement of alveolar process. b, Frontal view showing nasal impaction and lines of fracture.

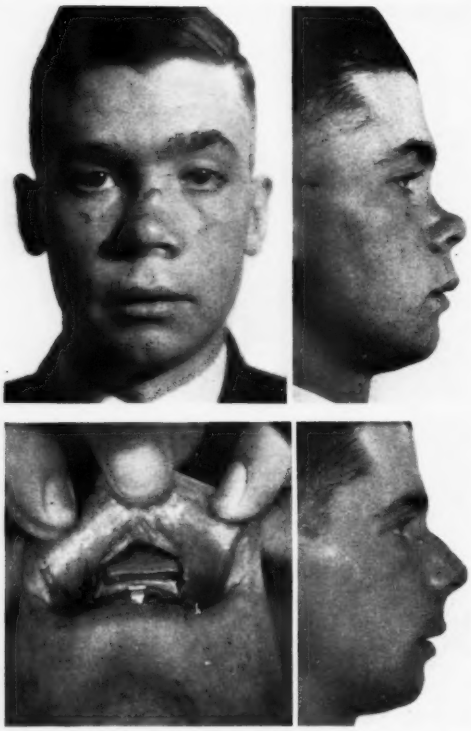


Fig. 16. above, Fracture of the nasal ethmoid maxillary compound with marked nasal obstruction. Inlay from below showing vulcanite retention plate in skin grafted cavity. Result after postnasal inlay.

Fig. 17. Roentgenogram of nasal ethmoid maxillary fracture, showing impaction of central compound and separation of alveolar process from bodies of maxillæ.

former methods fails, or if a difficult attachment of the orbital process prevents complete replacement. A small incision is made along the infra-orbital bony margin and the fracture line directly exposed. As there is usually a scar in this neighborhood, no harm results. When marked downward rotation of the body of the bone has occurred, it may also be necessary partly to mobilize the soft tissues of the cheek from the anterior surface of the body of the malar in order to allow the bone to be elevated into position. When the orbital and frontal process can be forced into their normal positions and the body does not show a tendency to slip back into the antrum, fixation is not required, but this is rarely the case. I have wired both the orbital and frontal processes with good results but prefer the more certain support of a mass of Stent's compound inserted through the buccal approach into the antrum, thus holding the malar out. The stent can be left for 10 days to 3 weeks without danger, provided adequate drainage into the mouth is assured. It is finally removed under evipan or G. and O. anesthesia, and the communication between antrum and mouth allowed to heal.

In certain cases, old or enfeebled patients, for instance, this strenuous program cannot be carried out and it is advisable to camouflage the defect by other means. Fat grafts or Gillies pedicled temporal muscle graft may be used to fill out the flattened malar region with good effect, though not with the excellence of contour which follows efficient bone replacement. Such operations are particularly useful where there has been actual loss of bone along the infra-orbital border. All such expedients must await complete healing of the original lesion, at least 3 to 6 months elapsing between the last sign of sepsis and the insertion of the graft (Figs. 14, 15).

### FRACTURE DEFORMITIES OF THE SUPERIOR MAXILLA

Fractures of the maxilla not involving other bones are uncommon except for those confined to the alveolar border. Here they are largely dental problems and as a rule receive efficient treatment because loss of dental occlusion calls attention to them at once. Occasionally old segmental fractures of the alveolus with outward or inward displacement of the tooth bearing segment can be corrected by careful refracture and

Fig. 18. a, Severe right frontal malar maxillary impacted with downward displacement of left eye; 6 months' duration. Marked diplopia. b, The same after malar maxillary replacement elevation of left eye and free fat grafting to left forehead, eyebrow, and left temporal region. Diplopia has disappeared.

resplinting with metal cap splints. Much can be accomplished in complete fracture of the alveolus with backward displacement of the whole arch by continuous forward traction of the ordinary weight and pulley extension type, provided union has not become impossibly firm. There are, however, two important varieties of old maxillary fracture which may fairly be described as the most serious of all the bony lesions of the face, first, because they are only part of a much more extensive bony lesion, and second, because they cause such an alteration in the bony facial configuration and make it so unrecognizable that treatment is imperative.

The first of these follows an extremely severe head-on crash and results in a telescoping of the entire nasal ethmoid maxillary compound with production of the well known "dish face" deformity. The second is the result of equally severe violence received over the malar prominence producing unilateral telescoping of the whole malar maxillary compound with loss or displacement of the infra-orbital plate and subsidence of the eye. These two characteristic fractures are practically never corrected at the time of their infliction because the life of the patient is usually in grave danger. Later they constitute extremely difficult problems.

*Nasal ethmoid maxillary fractures.* The direction taken by the fracture lines here is fairly constant and constitutes a circle drawn round the bony vestibule. The nasal bones and nasal processes of the maxillæ are usually comminuted to an extreme degree and crushed flat, or sequestrated through compound injuries. The inner half of each maxilla is fractured through the infra-orbital margin about the maxillary malar junction and the infra-orbital foramen, and below the bony vestibule parallel to the alveolar process. The entire block of bone within this circle is thrust bodily backward and either impacted into the ethmoid, or it is pushed, along with the ethmoid, backward into the anterior fossa of the skull by fracture of the cribriform plate. Occasionally the radius of this circular fracture increases to the extent of including the entire maxilla on both sides with or without the alveolar process, though this is usually left behind. The face itself assumes a Mongolian character with wide, high malar prominences, flat negroid nose, and sunken upper lip, an appearance which is aptly called "dish face" (Figs. 14–17).

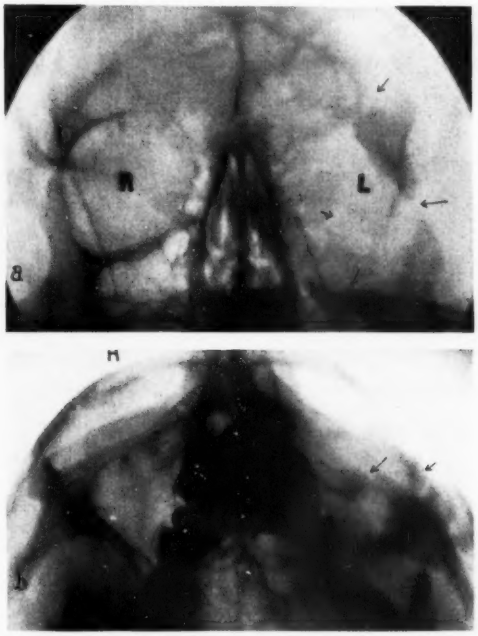



Fig. 19. a, Depressed fracture of left frontal with inward displacement of outer half of supra-orbital ridge. Depressed, comminuted, and impacted fracture of left malar maxillary compound, including infra-orbital plate; 6 months' duration. b, The same after malar maxillary replacement. Comminuted fragments built up as far as possible to restore the contour of the cheek and support the left eye at the correct level.

I am inclined to think that in cases in which consolidation has occurred, satisfactory elevation of this impacted mass of bone cannot be accomplished with any degree of safety. On the few occasions on which it has been tried some improvement was obtained, but the extreme nasal

flattening made a subsequent massive graft necessary. In those cases in which the upper alveolus takes part in the retroposition, gradual extension with weight and pulley attached to the splinted teeth has been found useful provided the fracture is not too firmly united. I have under treatment at the moment a patient in whom steady traction of 2½ pounds for 4 days has succeeded in advancing a telescoped nasal maxillary compound half an inch. This fracture is 6 weeks old. Unquestionably the best results, however, have been obtained by substitution or camouflage therapy. In the milder case a massive bone graft from the iliac crest to build out the bridge of the nose is usually sufficient, but it fails to bring the tip of the nose far enough forwards or to elevate the sunken upper lip. Wherever this is necessary one must resort to the postnasal inlay graft, by means of which the soft tissues are extensively lifted from the depressed bones and the resultant cavity lined with Thiersch graft. A prosthetic appliance serves to support the nose and lip and the external contour is thus restored to normal. Later the appliance can be discarded and a bone graft inserted.

*Malar maxillary fracture.* The same type of violence which produces the nasal ethmoid maxillary fracture will, if received over the cheek, produce malar maxillary collapse. It is an extreme degree of malar fracture which, in addition to malar maxillary impaction, produces serious displacement and comminution of the maxilla itself and results in depression or destruction of the infra-orbital plate, with downward displacement of the eye. In many such fractures there has been marked loss of bone, particularly of the body of the malar, the supra-orbital ridge of the frontal, and the infra-orbital plate of the maxilla, so that the soft tissues surrounding the globe project into the roof of the antrum.

In contradistinction to the nasal ethmoid maxillary fracture, treatment should, wherever possible, begin with an attempt at replacement. The operation is of the same type as that used for impacted malar fracture, but of the most heroic degree. It is directed towards producing sufficient disimpaction and elevation of the malar maxillary compound to bring the infra-orbital plate to its correct level. If comminution is extreme and bone loss marked, it is sometimes possible to create an infra-orbital shelf of fragments of bone which can be supported, until consolidation occurs, by a block of stent in the antrum. The triple approach is usually necessary. If elevation of the globe can be satisfactorily accomplished so that diplopia is overcome, then any other deformity of contour becomes of secondary importance and can be concealed by the insertion of fat, muscle, or cartilage at a later date (Figs. 18, 19). If, on the other hand, elevation of the globe fails by these means and diplopia persists, considerable improvement can be brought about by inserting between the periosteum and the infra-orbital plate strips of costal cartilage until the level of the orbital floor is raised to the requisite height. Thus treatment becomes entirely a matter of substitution and camouflage, adequate replacement being deemed impossible.

# THE PROPHYLACTIC AND ACTIVE TREATMENT OF SURGICAL INFECTIONS WITH ZINC PEROXIDE

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IT is stated that zinc peroxide was first made in 1810 by Thenard who thought that he had a simple dioxide of zinc, $ZnO_2$. Later, in 1884 Haass thought that its probable formula was $Zn_3O_8$. In 1891 Kouriloff figured it to be $Zn_2O_3H_2O$. Forcrand in 1902 decided that it was probably a mixture of four compounds. The preparation now available contains about 40 to 50 per cent $ZnO_2$.

The use of zinc peroxide as an antiseptic was suggested by Elias in 1903, and thereafter favorable results were reported in the treatment of several dermatologic diseases by Mayer and of acute and chronic eczema and leg ulcers by Hartung. Paucot was impressed by its favorable effect in a number of surgical infections, especially in anal fistula. He noticed an increase in suppuration for the first few days and a subsequent decrease of suppuration followed by a rapid development of vascular granulations which had a tendency to bleed. He was the first to report an unfavorable tendency of zinc peroxide to cake in the wound or in tortuous sinus tracts. He stated that he thought that certain wounds epithelized too quickly when zinc peroxide was used; but on the whole he considered that its advantages outweighed its disadvantages.

Hochstetter reported an unusual case of gangrenous ulcer of the face which responded favorably to the use of zinc peroxide and also a case of chronic endometritis. Chaput thought that zinc peroxide met every requirement of an antiseptic because it was non-toxic, non-caustic, non-irritating, and could be sterilized without affecting its antiseptic value. He did not state whether or not he had demonstrated its antiseptic action *in vivo* or *in vitro* against the infecting organisms cultured from the cases which he treated, but he was satisfied by the clinical results and attributed its action to the slow liberation of oxygen over a period of hours. He used it for fresh wounds, for "torpid" wounds, for burns, for vaginal infections, and for eczemas. He was particularly impressed by its favorable action in the postoperative treatment following the surgical removal of tuberculous bones and joints, in tuberculous ulcers, and in leg ulcers.

Vanverts confirmed the observations made by Chaput. He was particularly pleased by the decrease in suppuration, the disappearance of fetid odor, the rapid cleaning of the wound, and the prompt healing which took place following the use of zinc peroxide. He called attention to the fact that the zinc peroxide should be "pure" because on analysis certain ineffective samples had been found to be simply zinc oxide.

These experiences with zinc peroxide were reviewed by Laurent who determined to study the question and make it the subject of a doctor's thesis for the University of Paris. He presented some of its chemical characteristics and considered it the ideal vehicle for the slow constant delivery of oxygen to various kinds of wounds. He believed that it was not only bacteriostatic but that it detoxified the poisonous products of bacteria and favored the migration of leucocytes and their phagocytic action on the organisms. He demonstrated the slow but definite bactericidal or bacteriostatic action of zinc peroxide on staphylococci, streptococci, and Bacillus coli but did not take the opportunity to study its action on micro-aerophilic organisms or strict anaerobes. He added to the number of cases presented by the former authors 9 of his own, including varicose ulcers, diabetic ulcers, recent accidental wounds and burns, vaginal infections, and postpartum lacerations.

All of these authors employed zinc peroxide in the form of powder, of ointment, of lotion, or of pencils. All were impressed by the deodorant action and the stimulation of wound healing. Apparently none of them studied the bacterial flora of the wounds which were treated, or attempted to work out a reasonable plan for the selection of proper cases for this treatment.

Perhaps it was for these reasons that zinc peroxide was not employed more generally by others. Paucot hinted at certain unfavorable features of the treatment. It is probable that later experiences with it were not satisfactory because of certain difficulties in the preparation of

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zinc peroxide which we shall mention later. In any event it seems to have fallen into disrepute, because nothing is found in the medical literature about it between the years 1910 and 1927, when La Ferla and also Pignateri independently reported the successful treatment of trachoma with zinc peroxide.

## EXPERIMENTATION

We approached the subject from the bacteriological viewpoint. After studying a series of chronic undermining burrowing ulcers which had been treated unsuccessfully by every conceivable method, we concluded that the etiologic organism was a micro-aerophilic hemolytic streptococcus which could be consistently obtained only by anaerobic methods of bacterial cultivation.

It occurred to us quite independently that we were dealing with an organism that would be inhibited by a highly oxygenated environment and we went to Dr. Hans Clarke, professor of biochemistry of the College of Physicians and Surgeons, with the specific request that he suggest a non-toxic peroxide which would give off its oxygen slowly over a period of hours or days. After considering a number of possibilities he suggested zinc peroxide, a quantity of which had been recently sent to him for experimental purposes. Its chemical action was thought to be the simple liberation of oxygen with a residuum of zinc oxide. Following his suggestion and without any knowledge of its previous clinical application, we decided to use this zinc peroxide in the treatment of the chronic undermining burrowing ulcer then available. The success of the treatment was at once apparent and we also found that the causative organism was promptly killed after brief contact with the medicine *in vitro*. Subsequently two other similar cases were treated with zinc peroxide with striking success. During the treatment of the latter cases it was noted that the organism underwent a striking change in the wound. It lost its anaerobic, and then its hemolytic, properties. The progeny of the original organism became a non-hemolytic aerobic green streptococcus which was resistant to the zinc peroxide *in vitro*. This organism persisted in the wound but the lesion proceeded to heal in the face of its presence, behaving very much like an ordinary non-hemolytic streptococcus infection.

We reported the success of these cases and fully expected that success could be as easily obtained by others in similar cases if they used the methods which we proposed.

We proceeded further to use zinc peroxide in other micro-aerophilic and in anaerobic infections and found that it was effective both *in vitro* against all of these organisms and *in vivo* in all cases with infections of these two types, provided that the medication could be applied to the infected surfaces. In many cases, however, the application of the medication had to be preceded by an adequate surgical procedure.

During the second year of its employment we began to realize that the zinc peroxide was not always the same. The brilliant results in our early cases were not invariably duplicated in later cases and we began to hear that other surgeons were not having uniform success with the treatment.

We then found that the process of manufacture had been changed without our knowledge and although the manufacturer was supplying what was thought to be a better grade of material because it was finer and whiter and suspended more evenly in distilled water, it did not give the clinical results that we wanted. It was a matter of 6 months after we first suspected that the "new process" material was not up to standard that we finally persuaded the manufacturers that they must go back to the "old process." During this period, a considerable amount of ineffective material had been sent out to various surgeons over the country, and a questionnaire returned by them indicated that several of their number were not particularly impressed by the efficacy of the medicine.

But a return to the old process of making the zinc peroxide did not settle the matter. The manufacturers sent us various batches of material which they said were made in exactly the same way and yielded identical results on chemical analysis. We found, however, that the different batches varied greatly in their physical properties and in their clinical effectiveness. After groping around for some method of determining the difference between the effective and ineffective materials, we found that when they were suspended in distilled water in a large test tube, very obvious differences in their behavior became apparent. The effective material sedimented quickly in about 30 minutes, leaving a clear supernatant fluid. The ineffective material sedimented slowly, leaving a milky supernatant fluid. In the course of an hour small bubbles began to appear in the sediment in the clinically effective material, while none at all was observed in the ineffective. After 24 hours, the sediment in the effective material was raised up by bubbles of gas (which was later shown to be oxygen), while the sediment remained packed at the bottom of the tube in the ineffective material. At this time also the sediment in the

effective material was soft and curdy, while in the ineffective it was either closely packed or, in certain specimens, solidified as a plasterlike mold in the bottom of the tube (Fig. 1). Thus a test, which could be readily performed by anyone, became available to determine whether or not a given batch was effective.

It was of course necessary to go further and to determine the reasons for these apparent differences. This was done by attempting to duplicate the effective material after setting up its physical properties as a standard. We therefore measured the amount of oxygen gas produced by 5 grams of the dry powder in 150 cubic centimeters of distilled water and noted its evolution from hour to hour over a period of 24 hours. We also determined the amount of soluble oxygen in the supernatant fluid produced by 5 grams of the powder in 100 cubic centimeters of distilled water as determined by the amount of $KMnO_4$ two-hundredths normal solution which it was able to decolorize. We have also determined the bactericidal action of the different batches against relatively resistant anaerobic and micro-aerophilic organisms. We found that the effective material produced about 10 to 12 cubic centimeters of oxygen in 24 hours and during every hour at least 0.33 cubic centimeter was given off. We found that each batch of zinc peroxide varied from the others in the amount of soluble oxygen, but that each batch within a few hours reached an equilibrium which it maintained thereafter for several days. The ineffective batches made by the so-called "new process" not only failed to produce free oxygen gas, but failed to yield soluble oxygen in any great amount; they never hardened or caked, however. The ineffective batches made by the "old process" were either deficient in oxygen gas evolution or in soluble oxygen and frequently they showed some adhesive property in varying degree, sometimes slight and sometimes plasterlike.

For the last 2 years the manufacturer's chemists have repeatedly attempted to duplicate the effective material but so far they have not found out how to do it consistently. Only one batch of 8 or 10 approximates the standard. They put the same ingredients together under the same conditions for the same length of time and the end-results vary. Dr. Hal Beans, professor of analytical chemistry at Columbia University, and Dr. Hans Clarke, professor of biochemistry at the College of Physicians and Surgeons, have given much time and thought to the problem but have not yet found its solution; and until its solution is found we cannot have an adequate supply of effective material. The manufacturer has recently put two more chemists on the problem and recent specimens indicate that in a relatively short time the problem will be solved and that there will be an adequate supply for all who require its use. In the meanwhile other chemical firms are unwilling to attempt any solution of this difficult physicochemical problem which is much more complicated than it was at first supposed.

Fig. 1. Showing the test for effectiveness of zinc peroxide. Reading from left to right: Tube 1. Ineffective new process material No. 11, showing slow sedimentation, cloudy supernatant fluid, no gas formation. Tube 2. Ineffective new process material No. 3; similar to Tube 1. Tube 3 Ineffective old process material No. 2, showing rapid sedimentation but little or no gas formation and adherent sediment. Tube 4. Effective old process material No. 3, showing rapid sedimentation, good gas evolution and curdy sediment. Tube 5. Effective old process material No. 8, somewhat better than No. 3.

In our own researches we have tried to find some fundamental differences between the effective and ineffective materials. There is approximately the same percentage of zinc peroxide in both, but in one the oxygen is made available (possibly by some activating catalytic agent) and in the other it remains inert. We have tried to find the nature and mode of action of this activating agent by determining such factors as the hydrogen ion concentration, the electrical charge of the particles, minute impurities as revealed by the spectroscope, sedimentation rate, gas evolution, soluble oxygen production, and the effect of various methods of sterilization.

## CLINICAL APPLICATION

In the meantime, with a limited quantity of effective material available, we have applied it

clinically to a number of different kinds of surgical infections in which micro-aerophilic or anaerobic organisms were playing a part. We have also used it in cases in which the ordinary aerobic hemolytic streptococcus was the causative organism, because all of these bacteria are susceptible in varying degree to the effective zinc peroxide *in vitro*. In general, it may be said that the more strict the organism is in its anaerobic requirements, the more susceptible it is to zinc peroxide.

The active treatment of surgical infections with zinc peroxide should await the bacteriological determination of the flora of the wound and should be used only if those organisms are found which are susceptible to peroxides—namely, the anaerobes, the micro-aerophiles, and certain aerobes, including the ordinary hemolytic streptococcus. When an infection with these organisms has become established, particularly in cases of tetanus or gas gangrene, there must be a preliminary surgical procedure which will render it possible to apply the medication to the infected tissues in order that the main focus may be removed and the medication have a chance to act upon the residual infection. It is possible in many cases to make a clinical diagnosis of anaerobic infections but anaerobic methods of bacterial cultivation are essential for an accurate determination of the nature of the infection. It is surprising how many so-called first class hospitals have no adequate means for making anaerobic cultures. It is high time that this fault should be corrected and every surgeon should require adequate bacteriological service for his department. The time has passed when ordinary aerobic methods of bacterial cultivation can be accepted as satisfactory for the work of a general surgical service. Where such service is not available, zinc peroxide must be used with a reserved prognosis because in certain types of infection it will have no appreciable effect.

It is particularly indicated in those foul smelling infections of dental origin which occur in the face or neck in which the anaerobic non-hemolytic streptococcus and the spirochetes and fusiform bacilli of Vincent and Plaut are the etiological agents. Likewise in neck infections from perforations of the esophagus which are particularly virulent and necrotizing in their effect. Lung abscesses and chronic empyemas following lung abscess are particularly amenable to treatment with zinc peroxide, and the gratifying deodorant effect is almost immediately noted and appreciated by the patient and the whole ward. Chronic abdominal sinuses, either fecal fistulas or those arising superficially and invading the deeper tissues, are frequently due to susceptible organisms of intestinal origin. Progressive gangrenous infections of the skin due to a synergistic bacterial action or chronic undermining burrowing ulcers of the nongangrenous type are indications for the use of zinc peroxide after the necessary preliminary surgery which will permit close application of the medication (15). Human bites fall into the same category.

Gas gangrene or tetanus resulting from gunshot wounds or street injuries should be treated with zinc peroxide after the involved areas have been adequately cleaned. Occasionally gas gangrene has occurred following the amputation of gangrenous extremities or after the hypodermic or intramuscular injection of medication. In recent months we have treated all of these forms of infection successfully with zinc peroxide.

We have also been using zinc peroxide as a prophylactic in accidental and surgical operative wounds where contamination with anaerobic and micro-aerophilic organisms was suspected or inevitable. As one would expect, the prophylactic use of this material is more logical than the active treatment because the organisms have not yet invaded the tissues, but are merely on the surface. The application of zinc peroxide to the wound surfaces gives intimate contact with the organisms so that they are either killed promptly by the action of the zinc peroxide or are prevented from gaining a foothold and multiplying in the tissues and are either destroyed by leucocytes or are washed out of the wound. In such cases, as in the treatment of active infections, the zinc peroxide must be applied to every part of the wound surface because its action does not extend very far from its actual presence. Clinically it acts very much the same as it does on a blood agar plate. If a drop of zinc peroxide suspension is placed upon the surface of blood agar which has been evenly seeded with susceptible bacteria, after incubation a narrow zone about $\frac{1}{16}$ of an inch wide will be seen around the drop; in this zone there will be no growth of bacteria, whereas the rest of the plate will be evenly covered with luxuriant growth.

Inasmuch as anaerobic and micro-aerophilic organisms are prevalent throughout the alimentary canal and in the vagina, zinc peroxide is indicated prophylactically before all operations on the mouth, such as plastic procedures or the removal of tumors of the mucous membrane. One is surprised by the lack of inflammatory reaction of the mucous membrane when it is used as a mouth wash before and after such procedures.

No untoward results have followed the ingestion of zinc peroxide when it is so employed. It should be used before all dental extractions as a means of preventing those foul infections so frequently seen in the tooth socket and in the neck after such dental work. In these infections the non-hemolytic anaerobic streptococci and the spirochetes and fusiform bacilli of Vincent and Plaut are active, probably in symbiosis. For the same reason, zinc peroxide is indicated in all human bites. In these cases the wounds should be opened widely and thoroughly cleaned so that contact may be had with the fullest depths of the wound. The destructive action of these infections, if they gain a foothold with their tendency to invade bones and joints and tendons, is well known. If zinc peroxide were used before and after tonsillectomies, those extensive sloughs and the occasional fatal septicemia or lung abscess which are the bane of the throat specialists would, we believe, be greatly diminished. Operative or accidental wounds of the esophagus should always be left open and packed with gauze soaked in zinc peroxide suspension and the dressing renewed daily. Colostomies or cecostomies should be surrounded by packing soaked in zinc peroxide, both preliminary to and after their opening. Recently one of our surgeons has had a patient who developed an extensive gas gangrene of the abdominal wall when this was not done. Fortunately excision followed by the application of zinc peroxide controlled the infection. After excision of an anal fistula or fissure, the tract should be packed with gauze soaked in zinc peroxide suspension. The lack of inflammatory reaction and pain and tenderness will be noted both by doctor and patient when this is used. After hemorrhoidectomy the anal ring should be similarly packed during the postoperative period of enforced constipation. The patients so treated have almost invariably stated that pain was surprisingly absent after operation. In recent years gauze soaked in zinc peroxide has entirely replaced iodoform gauze in our practice.

For several years we have been using zinc peroxide as a preparation for the vagina preliminary to hysterectomy or the plastic procedures on the female perineum, and we have had a feeling of security against infection caused by the anaerobic organisms and the hemolytic streptococcus which are the chief offenders in infections arising in these regions.

Gunshot wounds are of course the wounds *par excellence* where zinc peroxide is indicated as a prophylactic, for the anaerobic organisms of tetanus or gas gangrene are always to be feared.

Fig. 2. The dressing sealed with fine meshed gauze impregnated with zinc oxide ointment.

If war ever comes again, and pray God that it will not, we believe that zinc peroxide will have a wide field of usefulness in every army hospital.

### METHOD OF APPLICATION

The early users of zinc peroxide employed the dry powder, and an ointment with a vaseline base or a watery suspension. Our experiments seem to indicate that the liberation of oxygen and the production of hydrogen peroxide depend upon the presence of water. We have found that the zinc peroxide is much more bactericidal in a water suspension than in oil. We have therefore applied it only suspended in sterile distilled water and have sealed the dressing so as to prevent evaporation.

The powder is sterilized in conveniently small quantities of 10 to 50 grams in glass tubes. The contents of one or more tubes is then thoroughly mixed by means of an "asepto" syringe with enough sterile distilled water to give an even creamy suspension about the consistency of 40 per cent cream. Effective material will usually be found to swell somewhat in the water so that it thickens; more water may have to be added during the course of the dressing. When the mixture is satisfactory it is spread over the surface of the wound with the syringe in such a way that it comes in contact with every part of the infected surface, particular care being taken to see that it gets under the undermined skin and down into the sinuses. It is frequently necessary to use a small catheter or a short tube to introduce it into the sinuses; this may be painful but it must be insisted upon, for the organisms will grow in any nook or cranny where the material has not been delivered. Strips of fine meshed gauze or silk are then dipped into the suspension and

introduced into sinuses beneath skin flaps and on the surface until the whole wound is covered, including the normal skin margins. The whole area is then sealed with a double layer of gauze impregnated with vaseline or zinc oxide ointment, as illustrated in Figure 2. This is prepared by placing the gauze and ointment in layers in an ice cream box of convenient size and autoclaving it so that the ointment permeates the gauze.

The dressing should usually be changed daily but in painful cases it may be left for 2 days at first. The gauze covering is then lifted off and the old peroxide mixed with exudate is washed off with sterile water or saline solution. The dressing is then reapplied.

Clinical improvement is obvious within 3 or 4 days after treatment is begun; the exudate decreases and the granulations become firm and red, undermined flaps begin to seal down, and sinuses shorten. If there are any areas where adequate contact is not being obtained, they will show up as areas of activity in which the granulations remain grayish or greenish and the exudate continues to be profuse. Greater care must then be used to afford closer contact or the involved area may require further incision or excision. Frequent cultures taken from various parts of the wound will give a check on clinical progress.

When the wound is clean, both clinically and bacteriologically, skin grafts of the deep Reverdin type should be employed to hasten epithelialization. These are held in place with a single layer of coarse meshed gauze sealed at the skin margin with collodion and covered with fine meshed gauze soaked in saline. This is sealed with vaseline gauze to prevent evaporation and after 24 hours the zinc peroxide dressing should be resumed, and the innermost layer of coarse meshed gauze may be removed on the following day.

SUMMARY

We have recommended the use of zinc peroxide as a prophylactic medication in the treatment of wounds likely to become contaminated with anaerobic or micro-aerophilic or especially susceptible aerobic organisms, and in the active treatment of infections already established by these organisms. We have indicated those clinical conditions in which these organisms are usually active.

We have found that certain preparations of zinc peroxide which may be purchased on the market are not effective. We have presented a simple test to show what preparations are effective. Effectiveness apparently depends upon the ability of the powder to evolve oxygen gas when suspended in distilled water or in tissue fluids. We have shown that in order to obtain consistently satisfactory results, it is not only necessary to have effective material but to apply it closely as a creamy suspension in sterile distilled water to every part of the infected surface and to prevent evaporation by sealing the whole dressing with vaseline or ointment.

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# INSURANCE COMPANY RELATIONSHIPS AND RESPONSIBILITIES IN COMPENSATION INSURANCE

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DURING the next 12 months, a million and a half men will be injured and sixteen thousand will be killed in the accidents of industry in this country. Occupational disease will exact a tremendous toll, the full extent of which cannot now be estimated. Not all of these accidents and diseases will occur in the great steel or automobile plants, or on the railroads. The great majority will happen in the small machine shop, the roadside garage, the corner bakery. Well over a hundred million dollars will be paid to injured men in benefits, and to the medical and allied professions for the care of these injuries under the several workmen's compensation acts. The execution of such a stupendous financial undertaking demands the application of the insurance principle in some one of its forms.

While some of our great industries and utilities have financial resources adequate to meet their liabilities under the workmen's compensation acts, by far the greater number of employers of labor do not. Insurance, then, is the only basis upon which the problems presented by the industrial casualty, with all of its social and economic implications, can be met. Whether this principle is to be applied through privately owned insurance companies or through politically controlled state insurance funds is a matter for discussion by the economists, although the thought is one quite worthy of the earnest consideration of the medical profession, especially at the present time.

Without the application of the insurance principle the social benefits of workmen's compensation would not be possible, nor the economic or physical needs of the industrially injured properly met.

Prior to the advent of workmen's compensation in 1911, the relations of master and servant were controlled by the English Common Law. The master was not held liable for the injuries sustained by his servant unless they were proved to be due to his neglect, his failure to provide a safe place for work, or safe tools with which to work. Provision was not usually made for any surgical care of such injuries. Settlement was made by agreement with the injured man, or that failing, by recourse to the courts. Usually the victim carried the burden alone, aided by charity, for lawyers were costly and the road to justice devious and rough.

Workmen's compensation changed that picture. It recognized as its fundamental principle the theory that man breakage was quite as much a charge against industrial production as machine breakage. Injured men under the new régime, which has spread to all but a very few of the states, are compensated for their injuries, regardless of fault, so long as the latter occur in, or arise out of, their occupation. Medical and surgical care is provided, without limit in some states, and limited in time or amount, or both, in others.

Workmen's compensation introduced into our social lives a principle foreign to anything that had ever gone before. It involved a principle that violated many of our American traditions, especially our medical traditions, for it provided essential care of a particular group of our population at the primary expense of another group, with the latter group paying also for the results of poor surgical care as well as for good. Certain adjustments in both medical and lay thinking, practices, and ethics were necessary, and the responsibility for leadership in educating each group rested with equal weight on the other. Just to the extent that the medical and lay group failed in this task respectively lies the measure of misunderstanding that has existed between the two. The American College of Surgeons has done more than it knows to draw from aloofness and indifference the finest minds in surgery and to interest them in the care of the industrially injured, with better understanding and clearer vision on both sides as a result.

Workmen's compensation benefits are not in any sense punitive. They do not represent "damages" in the commonly accepted meaning of the term. They are society's effort to keep the worker disabled at his job from becoming a public charge, or from losing his place among men when he cannot earn with his fellows. Later, if his recovery is less than perfect, his permanent partial disability benefits provide him with funds to augment his earnings until he can readjust himself, mentally and physically, to his impaired status.

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While workmen's compensation brought no particularly new responsibilities to the medical profession, it created a situation which should have brought home a realization of an opportunity for a higher and broader service to humanity. It offered a field of almost limitless scope in surgery and medicine, under circumstances that provided adequate if moderate remuneration, in a class of practice which heretofore had amounted to a labor of love. It presented an unparalleled opportunity for an analysis of some of the inadequacies of professional training, since end-results were appraised and compared in mathematical terms. Until the American College of Surgeons in 1926 recognized and met the challenge of the industrially injured, medicine had slumbered over the problem. The College's educational program to the medical profession, to industry, to labor, and to the insurance company has lighted the way to a better day. Much needs to be done, and I will later dwell more in detail upon the subject.

The insurance company acts as the depository of the numerous contributions known as premiums of its various policyholders, disbursing the funds thus acquired as needed to fulfil the legal obligations of each of its policyholders under the law. Since the cost of this insurance is a not inconsiderable item in the cost of industrial production, and hence an important factor in competition, and since this cost bears a direct relationship to the losses sustained by the industry, it is necessary that the insurance company, if it is to fulfil its obligation to industry and to society, concern itself with several important functions.

First, it must engage in a definite program of accident and disease prevention. Next, it must see to it that injured workers are restored to usefulness as quickly and completely as modern surgery can accomplish it, largely by arranging that such injuries be immediately placed in the hands of surgeons capable of producing such results. The third great responsibility of the insurance company is to see that, through careful investigation and administration, its claims are fairly and quickly paid, unjust or illegal claims resisted, and expenditures kept on a basis as economical as the efficient management of its affairs and the provisions of the law will permit. The first two of the functions just named, if successfully handled, make the execution of the third relatively simple.

Perhaps no single phase of the insurance company's activities is so worthy of mention in this place as its work in accident prevention. No other single agency has accomplished more, nor established a higher leadership in this field than has the casualty insurance company. The workman now finds his job the safest place in the world, safer even than his home, and safer than the highway, almost entirely through the intelligent cooperation between industry and insurance.

Accident prevention has long been considered the exclusive field of the engineer. It is becoming increasingly evident, however, that the physician has a function almost as important. Other factors than mechanical bear upon the causation of accidents. Perhaps some day we may decide that the human equation is even greater than the mechanical. I wish time permitted a more exhaustive discussion of this important potential relation of medicine and industry.

So-called "accident proneness" undoubtedly exists in many individuals. It has been amply shown that a relatively small percentage of motor car operators cause an extremely large majority of traffic accidents. Moreover, it seems that when an accident prone commercial vehicle driver is taken from the road and placed in the shop, his accidents continue at a rate which is often actually predictable from the past, and still more interesting, the individual's accident frequency continues even when he leaves his employment and remains at home. So far as I am aware, science has not told us why.

The pre-employment physical examination, as valuable as it may be made in accident prevention, should not be medicine's principal contribution to the problem. No doubt many flagrant causes of accident and breeding places for claims may be found at physical examination, but an industrial health program that stops when a physical defect is discovered and the prospective worker is barred from employment fails miserably in its broadest application. To be truly constructive, such a program must not only detect remediable defects, but must provide a way for the worker to have them corrected through competent medical care. Through medical guidance, the handicapped worker should be placed at tasks within his physical and mental capacity, where he can earn efficiently with safety to himself and to others. It must be remembered that the defective worker must earn his daily bread or become a public charge. To allow the latter is inhumane and costly.

There is a great need in industry for the intelligent application of the knowledge we have already gained in industrial hygiene, in the influence of such things as monotony, fatigue, anxiety, and morale to the prevention of accidents and the promotion of efficiency. The cast of the human mind is what produces individuals that are effi-

cient or inefficient, safe or unsafe in the jobs assigned to them. Much research awaits in the field of mental hygiene in its application to industry. Some few far-seeing physicians and industries have grasped the significance of mental hygiene in the study of accident proneness, individual efficiency, and job placement, but much of interest awaits the researcher.

Many of the diseases of man can be traced directly or indirectly to his occupation, or even perhaps to his lack of occupation. The environment in which one spends most of his hours of activity certainly must leave its mark. There are, however, certain specific diseases which arise as clinical entities, through the absorption of various poisons and irritants used in industry. Some of these diseases have existed and have been recognized since the days of Hippocrates, indeed, since the dawn of primitive industry. Of recent years, a strong tendency to compensate workers suffering from diseases of occupation has swept the country, resulting in the passage of laws in several states in which these diseases occur. Neither our time nor our immediate interest permit a discussion of the philosophical, social, or economic aspects of this problem now.

Suffice it to say that industry is confronted with one of the most momentous problems that it has yet encountered. It may well be alarmed, for it does not yet fully realize the magnitude of the situation. The very existence of some smaller industries is threatened, unless certain criteria are observed. New laws must be drawn from high ground; they must regard not merely the present, but the past and the future, as equally significant. The great chronicity of some of the more important of the occupational diseases must be recognized, and the rather peculiar behavior of silicosis particularly must be taken into account, not merely from the medical and economic standpoints, but from the standpoint of creating an insurable proposition. The interests of the employer as well as the employed must not be ignored. Interpretation and administration must be impartial and intelligent, so that the new laws are not allowed by indirection to become in reality compulsory health insurance or old age pensions. Above all, prevention of disease must be emphasized. State safety codes must be developed that are broad but likewise flexible, and they must be enforced vigorously. Such measures must recognize that the prevention of occupational disease is not solely an engineering problem, but even more a medical one. The question of occupational disease legislation is so finely balanced, that if unwisely managed, it will in all likelihood act as a boomerang upon the very class it is designed to benefit.

Much medical research is constantly in progress with the insurance industry as an active cooperator and often as an actual participant. The insurance company's particular emphasis, however, should be placed upon the application of the knowledge derived from such research to the individual plant and to the problems of its insured, and the insurance company which is not keenly alive to this responsibility is not doing its part in a work of the most profound social significance.

It has taken the insurance industry a long time to realize that the services of a surgeon are highly skilled and highly personal, cannot be written to specifications, and are not to be purchased on a competitive basis, like automobiles or potatoes. A few insurance companies, even in this enlightened age, still do not recognize this fact and continue to select their surgeons for a price. That the employer or his insurance carrier should select the surgeon for a given case is a legal right in most of the states, and that, with the selection of competent surgeons, this is an efficient and beneficial procedure is shown by the statistics of at least one of the great companies.[1] Of over 2,000 major consecutive fractures, treated in approximately equal proportion by surgeons selected by the company, and by surgeons of the injured man's choosing, it was shown that the surgical fees paid were almost identical in each case, but that an average reduction of over $100 each in compensation cost was noted in those cases treated by company selected doctors. The saving thus was in end-results, in decreased suffering, in future earning efficiency, and in lowered costs of insurance. Some day all insurance companies will learn that surgical skill and experience are the only criteria to be considered in the selection of surgeons to care for industrial injuries. Most of the companies already know this, and the situation is steadily improving.

It is quite evident to one whose work has made it possible for him to watch a great parade of injuries, their treatment, and their end-results cross his desk for many years, that the employer or his insurance company must continue to select the surgeon in workmen's compensation cases. The criterion must be ability, and not fees, and although the angle of approach must change, the basic fact remains unaltered. Physicians cannot be written to specifications as to the worth of their services. They can be, however, as to their training, experience and skill.

[1] Lazenby, A. D. Economic aspects of industrial fractures. Am. J. Surg., 1936, March.

Trauma, industrial and non-industrial, is increasing so rapidly that it now occupies almost a dominant position in the practice of surgery. Conditions fully warrant an increasing emphasis in medical education on this subject, and if our medical schools are to keep abreast of the needs of the day, they must apply that emphasis. The instruction of internes in competent minor surgery, in intelligent fracture management, in the thousand and one problems that trauma presents must be carried out on a systematic and scientific basis.

There is a need in most of our great hospitals for wards and services devoted to the care of trauma, organized and operated systematically, with facilities for adequate out-patient care, under capable supervision. Especially is this true in teaching hospitals, not merely for undergraduate instruction but for postgraduate as well.

Facilities for systematic postgraduate instruction are urgently needed, so that the average practitioner can learn to recognize a severed tendon or nerve, to treat properly an infected finger, and to diagnose an obscure fracture. All too often he sits wide eyed on the bench and watches his master perform an arthrodesis on a spine or a graft on a femur. Postgraduate instruction in traumatic surgery must be made available to physicians in accordance with their training and needs. Far better teach a man what he should not attempt than show him a procedure beyond his capability to execute.

With equal force, the foregoing applies to the diseases of occupation, silicosis, lead poisoning, and arsenic intoxication. These things are increasing in our industrial life and will increase in greater ratio as our physicians learn to recognize them. They deserve a place in our medical schools, in our hospital wards, and in our postgraduate schools.

And so I repeat, that until more of our profession are trained and ready to treat the industrially sick and injured adequately, an outside agency, charged not only with financial responsibility, but a high moral one as well, must see that competent care is provided for them.

The problems of industry, medical, surgical, and hygienic are not merely vital to the doctor, the insurance company, and industry, but to every stratum of society. These things present a challenge to insurance, but a challenge no less to the entire medical profession to assume leadership in such matters.

It is to be regretted then that two of the most potent influences for industrial betterment in this country should be confined in their contact largely to petty bickerings over fees and fee schedules, to medicolegal and not purely medical problems. Medicine guards the door to industrial health, happiness, and efficiency, and insurance and industry hold the key. Let us hope for the success of this College's efforts to open that door, that "man might have life, and might have it more abundantly."

# THE GENERAL MANAGEMENT OF INJURIES

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WITHOUT any attempt to enter into details, certain general factors bearing on diagnosis or treatment may be mentioned in paragraph form. Some of these are so generally accepted that they may be said to be the axioms of traumatic surgery.

It is pertinent to say that the treatment of the injured is increasingly engaging the attention of the profession throughout the nation.

If we broadly gauge the sources of injury we can say that 60 per cent are due to vehicles, 20 per cent occur in industry, 10 per cent in the ordinary hazards of every day life, and the remaining 10 per cent can be allotted to sports, self inflicted injuries, and miscellaneous sources. Thus by far the greatest source of origin is transportation, and the automobile far outstrips the railroad as the main factor.

Motor trauma has created new types of injury that hitherto were wholly unknown, and, indeed, it has made many of the rarer types of trauma exceedingly common. A factor of increasing importance is the aeroplane and already it is looming large on the horizon of traumatology.

The automobile and aeroplane have brought major traumatic surgery to the crossroads, and for that reason the doctor in the most remote hamlet may suddenly be confronted with a surgical situation of extreme gravity; and further, the victim of this surgical exigency may be a leading citizen of our country. Trauma is no respecter of age, sex, race, station in life. There is no selectivity. There is no period of immunity, for at the sudden onset the patient may be immediately transferred from well being into a state of permanent disability. Another peculiarity of traumatology is that during the course of treatment the patient will probably undergo the scrutiny of many doctors, and legal and other agencies, and to that degree traumatic surgery is the most public type of private practice.

Thus primarily in the interest of the patient, and also of the doctor and the public, it is necessary that the profession become acutely surgically minded in the care of the injured. Traumatology has already become a recognized specialty, but because of the emergency nature it will always continue to be a problem of the general practitioner. And it cannot be too strongly stressed that the initial care given to the injured may determine the entire outcome.

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If we attempt to visualize our problem from a regional standpoint, we can say that traumatology concerns itself with three areas:

1. Soft part areas—
   Wounds, contusions, sprains.
2. Skeletal areas—
   Joints—
   Sprains, bursitis, synovitis, arthritis, cartilages.
   Bones—
   Dislocations, simple (closed); fractures, compound (open); osteomyelitis; tumors.
3. Systemic areas—
   Musculotendinous.
   Nervous: brain, cord, peripheral.
   Thoracic: lung, heart.
   Abdominal: gastro-intestinal, spleen, liver, genito-urinary.
   Special sense: eye, ear, speech.

This is equivalent to saying that traumatology affects every part of the body and for that reason it is general surgery in the widest sense. A basic training in general surgery should be a prerequisite if a surgeon intends to specialize in this domain.

In an attempt to collate some of the factors leading to success in the management of injuries, I venture to present to you in 38 paragraphs some salient features:

1. Immediate treatment usually means easy treatment and early recovery. There is a "golden period," namely, within the first 6 hours after trauma, and wounds or fractures treated in that interval are generally freed of complications.

2. Shock and hemorrhage are the two most common serious incidents in trauma, and their recognition and control should always precede any definitive examination or treatment.

3. Pain should be promptly relieved, and for that reason a large dose of morphine, often half a grain, is indicated, unless masking of symptoms is feared. When a patient is hurt, he has pain, and added pain means added shock.

4. If the violence is adequate or undetermined, suspect and expect an adequate effect. Be especially guarded in head, back, and pelvis injuries.

5. Do not disregard local or persistent pain; on the contrary, look and see rather than wait and see.

6. Anesthesia should be used more generally. Beware of chloroform in trauma; nitrous oxide is the safest, ether drop by drop the next. Evipal given intravenously is effective for quick induction, short duration, and prompt return of consciousness.

7. Traumatology is in the gadget stage of development, but complicated and fancy apparatus is more of a burden than a benefit.

8. Safety first is the slogan in traumatic surgery; next is speed; and next, simplicity.

9. Adequate cleansing of wounds by the plentiful use of soap and water is the best safeguard against infection. Antiseptics are no substitute for ordinary cleanliness.

10. Primary suture of wounds should not be done unless they are surgically clean. This means that all frayed or devitalized tissue has been removed and the patient has been adequately treated within the golden 6 hour period.

11. By far the safest method for wound treatment is to employ primo-secondary suture after thorough soap and water cleansing. This implies that the sutures are placed, but not tied until the third day.

12. Every wound not made with surgical intent is already infected and should be so regarded. In other words, every accidental wound is already infected, irrespective of source, site, or size. Therefore drain every wound, using a rubber band in the small group, folded rubber in the intermediate group, and a pipe cleaner in the larger group. Beware of gauze because it plugs; to ram it into a wound is taxidermy and not surgery.

13. Give tetanus antitoxin in any wound which is soil contaminated, and in all which involve heavy muscled areas, notably in the region of the buttocks and thighs.

14. In wounds already infected, do not incise unless there are 3 indications: local swelling, local pain, local induration. Never incise for redness alone, for red streaks alone, for swollen glands alone.

15. When incising for infection, especially in hand infections, follow the main underlying tissues, rarely cross cut, and make the incision long enough and deep enough to be self gaping.

16. Rest, elevation, and heavy protective dressings will allay pain and prevent migration of infection in many wounds of the extremities.

17. Frequent dressings cause pain and often lead to re-infection; practice the hands off technique in dressings and hence use an artery clamp and a thumb forceps instead of fingers.

18. Provisional reduction should be provided in every dislocation or fracture. This does not require any elaborate paraphernalia and it always makes definitive reduction and splintage easier.

19. Primary suture in fractures is dangerous; primo-secondary suture is safest and just as effective.

20. Guard joint penetrations with extreme care.

21. Ecchymosis late in onset, distant from the scene of trauma and irregular in outline, is pathognomonic of fracture. Look for it behind the ear in skull fractures, in the perineum in fracture of the pelvis, and on the sole in fractures of the foot.

22. Splints first of all should be safe; hence beware of using encircling plaster-of-paris casts in fresh fractures, and be especially guarded in using them near the elbow, notably in children. Next, splints should be simple. The third requirement is security. Two piece molded plaster-of-paris splints are the best because they fulfill the "three S's" named, and in addition they are custom made and can be used throughout the duration of the case. Fancy splints already shaped are usually inefficient because they need padding or remodeling before they fit. It is better to make the splint fit the patient than to require the patient to fit the splint.

23. There are four R's in the fracture lexicon, namely: (1) recognition (differential diagnosis); (2) reduction (setting); (3) retention (splintage); (4) restoration (functioning). Of these, reduction is the most important and on this the outcome is predicated.

24. The need for roentgenograms is imperative, but we should use this aid more for checking the results of treatment than for checking the accuracy of diagnosis. To await x-ray examination before reduction gives opportunity for so called secondary swelling to develop, and if we would prevent this, our setting should be within the golden period.

25. Reduction of a dislocation or fracture means that we replace it into a position exactly opposite to that in which we originally found it. Hence we need not try to remember the various shifts or maneuvers necessary to accomplish this, but instead we should aim at restoring the original alinement by traction, manipulation, and posture.

26. There are in reality only two types of fracture, namely: type I, in which the broken ends are overlapped or otherwise non-contacting; type II, in which the ends are not overlapped and are contacting. Either of these may be simple (closed) or compound (open).

27. Type I fractures, the displaced group, require setting and splinting; type II fractures, the non-displaced group, require splinting only. In other words, let the type II group alone if the

alinement is good; furthermore, fractures of this group need not be splinted so securely as those of the other group.

28. Any fracture is well reduced if three tests are fulfilled: (a) alinement and bony landmarks are restored; (b) deformity is caused to disappear; (c) pressure produces no recurrent displacement.

29. Every fracture passes through two stages in repair, namely, that stage in which nature's cement or callus is still partly solid; this I call the "lead pipe" stage and in long bones it appears in the third week, usually about the sixteenth day, when union is not yet solid. The second is the "iron pipe" stage; this usually appears after the fifth week and union is now solid.

30. Splints should be removed gradually, the least necessary part first, usually the anterior half. Always keep the adjacent parts active during splintage, especially the fingers and toes.

31. When can the patient use the fractured part? The "tests for usage" are in terms of the patient's response to certain test motions as indicated by the presence or absence of pain, swelling, heat, or redness. The broken forearm, for example, is guardedly moved or percussed and the wrist is pushed against the fixed elbow. This is likewise true in the broken leg; the heel being pushed against the fixed knee. Next, weight bearing is tried, and if there is no prolonged reaction, then the limb is ready for a guarded attempt at actual function. Caution must be observed: Before finally discarding the splint let the patient wear it during sleep to avoid the possibility of some unguarded twist.

32. Walking splints with a rubber heel attachment will make many patients ambulatory in days instead of weeks, in well reduced fractures, especially those in which the fragments are securely notched. Beware of spiral or smooth transverse fractures in this class because they are prone to slip.

33. A brief time table for needed roentgenograms is as follows: (1) before reduction, but not essential; (2) after reduction and splintage; (3) a week thereafter; (4) about the sixteenth to the twenty-first day; (5) before removal of splintage; (6) final check up prior to release from treatment. Do not disregard the patient's statements, such as, "I feel it move inside the splint," or "I felt something give way." The patient may be right. After the sixteenth day, however, slipping is very unlikely.

34. End-results should be rated in terms of function rather than in terms of form and they should be named in numerals rather than by such words as "good," "fair," or "poor." The Boston method is to base the rating on anatomic outcome, denoted by A; the economic outcome, denoted by E; the functional outcome, denoted by F. My own procedure, in use for over a decade, is to evaluate by giving 60 per cent for perfect function and 20 per cent each for perfect union and perfect contour; thus the formula is F = 60 per cent, U = 20 per cent, C = 20 per cent. The total is 100 per cent if all three are perfect. This numerical rating can be used before treatment and throughout the whole period of observation; it has proved satisfactory for all sorts of trauma.

35. Operation for the treatment of fractures is becoming increasingly rare. Plating has practically disappeared, and, indeed, the use of nonabsorbable material in traumatology is almost as uncommon as it is in general surgery. There are, however, certain fractures in which operation is the treatment of election and some in which it is necessary. Among these may be mentioned fracture of the patella, of the olecranon, and some fractures of the forearm.

36. In fracture of the neck of the femur, treatment by operation is again being tried out vigorously, but let me warn against undue reliance upon this procedure.

37. Any fracture that resists two or more well planned attacks by the closed method should be considered as coming into the operation class, assuming that the patient, surgeon, and hospital are adapted thereto.

38. "Once an osteomyelitis always an osteomyelitis" is an old saying, and unfortunately this dictum is just as pertinent today as it ever was. The treatment by vaseline pack is but an adaptation of methods revived during the World War by the British in their "Bipp" treatment and they abandoned it before it became popular as a postwar measure. The maggot treatment is to me a relic of barbarism.

These are some of the precepts and practices that should guide and govern us in our attempted conquest of the three D's of traumatology: death, deformity, disability.

# HERNIA IN INDUSTRY

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HERNIA is one of the most common disqualifying defects that we encounter in our physical examinations of applicants for employment. During the past 15 years the majority of the larger industrial institutions have required a physical examination of all applicants for employment and many have instituted an annual or bi-annual re-examination of all employees in the service. The large carriers or class A railroads (railroads having a net income of over $1,000,000 a year), at the suggestion of the medical and surgical section of the association of American railroads, were among the first, if not the first, to establish these physical examinations. It was thought that the employees might resent these re-examinations, but it was found that they welcomed them since they learned the value of having their defects, which in many cases are minor at the time of examination (such as poor teeth, infected tonsils, potential hernia, etc.), pointed out to them, so that the defects could be corrected before complications occurred, leading to serious difficulties which in a short time would disqualify them from continuing in the service.

With this brief introduction I will confine my remarks to the subject of hernia.

The following paragraph was written by a special committee on traumatic and industrial hernia appointed by the medical and surgical section of the Association of American Railroads:

> The great increase in social legislation in recent years has made the subject of traumatic hernia one of vital importance to every industrial organization. The Workman's Compensation Act, which now has been adopted by nearly every state in the union, classifies hernia as an injury, and is compensable.

The rules governing the reporting of railway accidents to the interstate commerce commission became effective January 1, 1922. They state that:

An initial case of hernia resulting from a blow or strain from a violent effort and developing immediately thereafter is reportable as an injury.

Hernia developing gradually and not definitely connected with exertion at a specific time and place should not be classified as an injury.

These rulings make the preoccupational physical examination of all applicants for employment imperative. One can readily see the financial burden to a large industrial institution if all with hernias are entitled to operations, hospital expenses and compensation, to say nothing of the large number that have taken their cases to court and recovered large sums through jury trials. I cite two recent legal decisions in favor of claimants.

CASE 1. February 8, 1936, Idaho. Claimant fell April 13, 1935, while on duty. Abdominal pain and nausea followed but he continued at work. April 15, while hanging a bunch of bananas, pain and nausea recurred. Pain increased and on April 17 he was operated upon. Mesenteric hernia was found. The industrial board denied him compensation. The district court reversed the decree. The supreme court of Idaho sustained the district court in favor of the claimant.

CASE 2. August 8, 1936, Texas. Claimant alleges that he developed a right inguinal hernia lifting a keg of nails in the course of his employment and submitted to an operation. For a number of years prior to operation he had a chronic inflammation of the spine and "hypertrophic spondylitis." A long confinement in bed aggravated his hypertrophic spondylitis and caused spastic colitis. As a result of these sequelæ he could not do manual work. Industrial board awarded him compensation in accordance with the Texas Workman's Compensation Act. Claimant then sued his employer's insurer in United States district court in Texas to set aside the board's award and to recover instead compensation for total permanent disability which he won. The insurer then appealed to United States circuit court which affirmed the judgment of the trial court in favor of the claimant.

The Workman's Compensation Act of Nebraska classifies hernia as an injury, provided there was an accident and hernia resulted, none being present previous to the accident; and under this act the courts have held that hernia is compensable. By special enactment of the state legislature of Nebraska, all employees of railroads engaged in interstate commerce are specifically exempted from the provisions of this act.

Employees on the Union Pacific Railroad number approximately 50,000, but only those employed in the train, yard, engine and signal service are required to undergo a bi-annual physical examination. On the eastern district of the Union Pacific Railroad, in 1935 we examined 7,967 men whose duties pertained to the operation and movements of trains.

## FREQUENCY OF HERNIA

Three hundred and eighty-three of this group were found to have had a hernia operation at some

Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

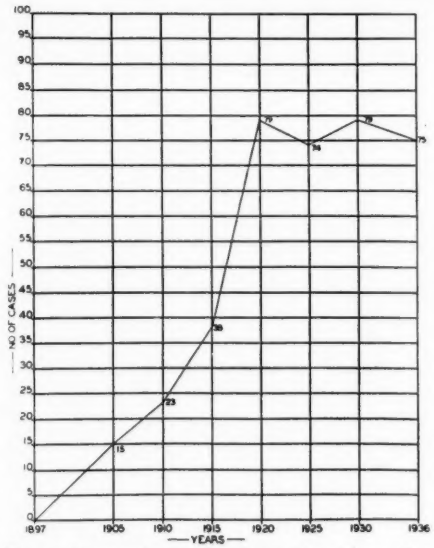


Fig. 1. Increase in number of operations from 1897 to 1936: 383 operated upon 1897–1936; 318 operated upon, personal cases.

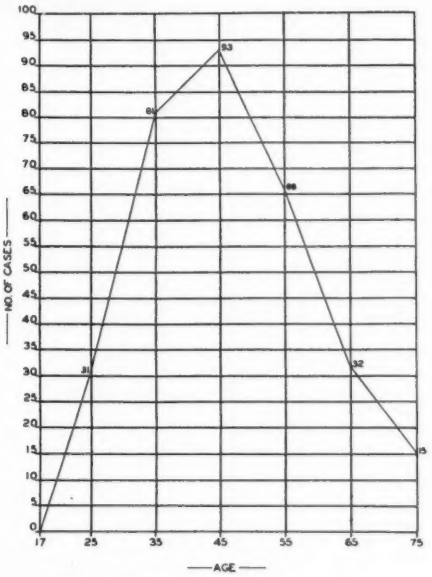


Fig. 2. Ages as shown in 1935 survey.

previous time; 377 new cases (potential hernias included) were found, making a total of 760 or 95 per 1,000 employees examined.

Dr. J. D. Comrei of England, in his observation of the examination for military service of 10,000 men, 18 to 41 years of age, found that in the south of Scotland, 36 per 1,000 had hernias. In London and in the southeast area the number of hernial subjects varied from 17 to 56 per 1,000. In one group of Londoners, 18 to 30 years of age, the rate was 6 per 1,000. In those between 30 to 40 the rate was 16 per 1,000. In those between 40 to 50 the rate was 24 per 1,000. In one group from Manchester the rate was 125 per 1,000.

Sir Arthur Keith of London says that "20 of every 1,000 male inhabitants of Great Britain are ruptured."

### OPERATION FOR HERNIA

The anesthetic may be general, local, or spinal, depending on the case. The most popular methods are the Bassini, Ferguson, and Gallie. The type of operation is usually decided after the incision has been made and parts inspected. Decision is based on: (1) age of patient, (2) physical condition, (3) type of hernia—direct, indirect, or recurrent.

Figure 1 shows increase in operations since physical examinations were instituted. Note the number: from 1897 to 1920 there were 76 cases; from 1920 to 1936, 257 cases.

### DISPOSITION OF CASE

If the operative result is good and the employee has only clerical or light duty to perform, he is returned to service in 4 to 6 weeks. If he is a shop employee or section laborer and he has heavy work to perform, we attempt to rehabilitate him and place him in a position of the same payroll classification which would not require him to do heavy lifting or straining for a few months, such as crossing watchman.

If the employee is along in years (from 61 to 70), and his work is heavy, and if in my opinion it would not be to his best interests to return to his former position, and if we are unable to rehabilitate him on account of organization and crafts agreement, and if he has had 20 years of continuous service, we advise him to retire and take his pension. His pension allowance would be 1 per cent of his average earning for the past 10 years, multiplied by the number of years in the service; this is usually sufficient to care for him during his declining years.

### RECURRENCE OF HERNIA

The causes of recurrence are: (1) infection, (2) postoperative hematoma, (3) fatty degeneration of muscles, (4) unrecognized presence of a fat hernia (preperitoneal fat), (5) pressure necrosis from tight sutures, (6) previous operation, and (7) too early return to heavy duty.

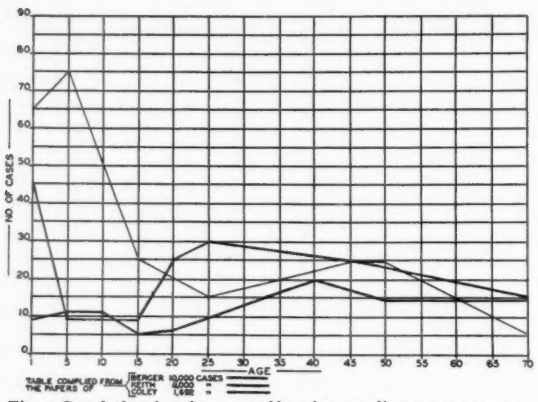


Fig. 3. Graph showing the onset of hernia according to age per 1,000.

In reviewing some of the available literature, I found that the percentage of recurrences varied greatly at the larger clinics.

| | Recurrences | Percentage |
|---|---|---|
| Dr. Coley's clinic, 1890 to 1918 | | |
| 5525 inguinal hernias | 26 | 2.45 |
| 760 cases traced for 1 year at a later period | 49 | 6½ |
| 388 cases fascia transplant | 65 | 16 |
| Dr. Wolfer's clinic | | |
| 2238 cases | 111 | 5 |
| Mayo clinic, 1915–1925 | | |
| 1619 inguinal hernias | 17 | 1.8 |
| Dr. Huston's clinic, Dayton, Ohio | | |
| 1500 cases | 12 | 0.8 |
| Union Pacific eastern district | | |
| 383 cases | 30 | 8 |
| 318 cases (personal railroad cases) | 5 | 1.5 |

Dr. Gallie of Toronto, in the Hunterian lecture delivered at the Royal College of Surgeons of England in 1924, stated that the examination of hospital records shows a recurrence of 40 to 50 per cent of all direct hernias operated upon.

The incidence of recurrences of our railroad of 7 per cent plus is higher than the larger clinics, due, I believe, to the close check on the physical conditions of our employees in the bi-annual physical examination. Every employee suffering from a hernia or a potential hernia is known and tabulated. He is re-examined every 2 years and if he has chosen to wear a truss in lieu of submitting to an operation, he is examined every 3 to 6 months.

To follow up 1,000 to 5,000 clinical cases over a period of from 5 to 10 years is almost impossible as all know who have tried this in school clinics.

## CONCLUSIONS

1. Hernia is a very common condition found in the male.
2. An employee with a hernia is a potential hazard.
3. The efficiency of an employee with hernia is reduced 25 per cent.
4. Hernia is a condition which yields readily to surgery.
5. Mortality in operation for simple uncomplicated hernia is practically nil.

# REPORT ON 1936 SURVEYS OF MEDICAL SERVICES IN INDUSTRY BY THE AMERICAN COLLEGE OF SURGEONS

M. N. NEWQUIST, M.D., Chicago, Illinois

UP to October 1, 1936, surveys have been made of the medical services of 1,593 industrial establishments in the United States and Canada. Of this number of establishments which employ approximately 5,000,000 workers, 817, or about 51 per cent, are approved or provisionally approved by the American College of Surgeons. While most of the surveys have been limited to plants having 500 or more employees, it is realized that it is the smaller establishments in general that lack adequate medical service and that offer the most fertile field for rendering a constructive service. It is contemplated, therefore, to include more of the smaller industrial organizations in the future surveys.

Increasing interest and co-operation in this movement to make efficient medical service readily available in industry through effective organization has been manifested by the managements of the various industrial organizations. Recommendations of a practical nature only are made following each plant survey by the College and it is most gratifying to note the prompt response to these suggestions. Obviously, legislative and economic stimuli are important factors in the progress made in the field of industrial medicine and surgery, but it has also been demonstrated repeatedly that the desire on the part of an employer to have an approved medical service has prompted corrective or constructive measures that might otherwise have been neglected. Furthermore, by publishing annually the list of approved medical services, an effective medium is provided for totaling the score of progress in this field.

In the brief time allotted for this report, there are three subjects that have been brought to our attention in our recent surveys and that should be presented at this time. These subjects of timely interest are: first, the scope of an industrial medical service; second, the confidential nature of physical examination records of employees; and third, an economical plan for providing adequate medical service for the smaller industrial establishments.

Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

## SCOPE OF AN ADEQUATE INDUSTRIAL MEDICAL SERVICE

Recent legislation relating to occupational diseases and to social security has led employers everywhere to reorganize their medical services along more efficient lines. The question then has arisen as to how far an employer should go in providing such service. The following general medical program is recommended as being adequate for any industrial establishment, regardless of size or type:

1. *Pre-employment physical examinations.* These examinations should include all persons connected with the organization, male and female, executives as well as employees. The degree of thoroughness of the examination may be modified according to the nature of the occupation. An appraisal of the physical and mental status of a worker not only facilitates placement in a position for which he is best fitted for productive work, but the accident prevention factor that can thereby be effected is also of great importance. Many accidents are prevented by not placing a workman having physical impairments in the type of job in which his employment would constitute a hazard to himself or to his fellow workers. Workers who are unemployable on account of having correctable physical defects should be encouraged to have such defects corrected in order that they may be restored to a normal earning power and that the burden on society may thereby be lessened.

2. *Periodic health examinations.* All persons connected with an industrial organization should be given the benefit of these examinations. Most employers are now examining periodically their workers who are exposed to definite occupational disease hazards, and a limited number of employers are examining all of their wage earners at intervals ranging from 1 to 5 years.

Surprising as it may seem, in very few instances are the key men—those whose services are the most valuable to the organization—included in these examinations. Every organization has eventually a financial investment, direct or indirect, in all of its workers and it would seem to be "good business" to conserve these assets. The periodic health examinations should, therefore, be directed

particularly to those in key positions, workers in hazardous occupations, food handlers, those with correctable physical defects, and those over 40 years of age.

The application of pre-employment and periodic health examinations in industry, linked with the proper follow-up and co-operation with private medical practitioners, offers one of the most suitable opportunities for effecting preventive medicine that exists in this country today. More employers instituted physical examinations of their workers in the past year than in any year, with the exception of the period that immediately followed the enactment of workmen's compensation laws. In contrast to the numerous physicians of 40 years ago who were busily engaged in treating persons having typhoid, diphtheria, and similar diseases, thousands of young physicians of today are employed in industry to make these examinations and to act as medical directors. The industrial worker is being transferred from the obsolete repair department to the modern maintenance department. While the number of physicians serving in this maintenance department is rapidly increasing, the saturation point has not yet been reached.

*3. Efficient care for all industrial injuries and occupational diseases.* The workmen's compensation laws require employers to provide this service, and, fortunately, the realization on the part of the employers and insurance carriers that the best medical and surgical service is the cheapest is becoming more widespread.

*4. First aid and advice for employees suffering from non-industrial injuries and illnesses while on duty.* Reasonable first aid service may be provided in order to keep the worker on the job, but for further professional care such employee should be referred to his own family physician. It is not the purpose or license of industry to practice medicine. While the compensation laws require that employers provide certain medical, surgical, and hospital care for injured workmen, state supreme courts have ruled to the effect that corporations cannot practice medicine. In remote or isolated communities it may be necessary for industrial organizations to provide medical and hospital care for employees suffering from non-industrial injuries and illnesses, but elsewhere industry should draw upon the existing medical and hospital facilities. A number of corporations that established extensive medical services which exceeded their legal prerogatives, have recently had their medical programs curtailed or stopped by court order or by legislative action. It is urged, therefore, that the various industrial managements give adequate consideration to the scope of their medical service, lest it go too far.

*5. Medical supervision of plant sanitation and of all industrial health measures.* It has been observed that legal and engineering problems in industry are usually delegated to legal and to engineering hands, respectively. A similar disposition of medical matters in industry, however, has not yet been generally made, although this particular situation is improving. It is imperative that industrial physicians and surgeons interest themselves more in the administrative and preventive phases of industrial medicine if the desired results are to be more readily obtained. Similarly it is hoped that industrial leaders will confer the proper authority upon those to whom they entrust the responsibility for their medical services. In turn, they should demand results from their medical directors.

Regulations for the medical service as a whole should be formulated, signed, and enforced by the physician in charge. Furthermore, it is the duty of the medical director to be ever on the alert in order to determine the health hazards that may exist in the plant and to make the indicated recommendations for their elimination or control. No medical department can expect to obtain a maximum of efficiency, however, without maintaining a co-operative working relationship between the medical and all other departments of an industrial organization and without maintaining the good will of the employees through unbiased and meritorious service.

Surveys made by the College have revealed that inadequate medical supervision invariably permits abuses or inefficient practices to creep into a medical service, and it is for that reason that many industrial medical services do not merit approval.

### THE CONFIDENTIAL NATURE OF PHYSICAL EXAMINATION RECORDS OF EMPLOYEES

In the march of industrial progress, workmen's compensation laws, and other new factors, the worker often finds himself confronted with situations which had their inceptions years before but over which he now has no immediate control. In order for an employer, for instance, to effect the desired preventive health measures, the applicant for work is given a physical examination which in many instances includes urine, roentgenologic, blood and serologic examinations. What happens, then, to the record of such examinations? Does it become a public document or in this connection does the workman still have a few so called constitutional rights?

TABLE I*

| | |
|---|---|
| Total | 100,000 |
| Motor vehicle | 37,000 |
| Home | 31,500 |
| Other accidental causes (public) | 18,000 |
| Occupational | 16,500 |
| Disabling injuries | 9,340,000 |
| Wage loss, property damage, medical expense | $3,450,000,000 |

*National Safety Council.

TABLE II*

| | |
|---|---|
| Heart disease | 239.9 |
| Cancer | 106.2 |
| Accidents | 79.9 |
| Pneumonia | 79.4 |
| Cerebral hemorrhage | 76.7 |
| Chronic nephritis | 74.2 |
| Tuberculosis | 56.6 |

*Bureau of Census.

Civil courts have ruled to the effect that the record of a physical examination, no matter whether the examination is made in a doctor's office, a hospital, or an industrial establishment, constitutes privileged or confidential information and should be so treated. These courts have further stated that to destroy the confidential nature of such information would be a greater loss or injustice to society as a whole than would be the loss sustained in the suits that would be lost on account of such confidential information being withheld.

The workmen's compensation laws, however, have specified that the industrial commissioners may subpœna such records as may have an important bearing upon the award that is to be made in connection with a worker's claim for disability. The workmen's compensation laws which state the exception on this issue seem to take precedence over the older findings of the civil courts. Until the time that an injured employee claims compensation and a hearing, however, the physical examination record is immune from the provisions of the workmen's compensation acts. Therefore, we reiterate that if pre-employment and periodic physical examinations are to be of greatest value both to employer and to employee, and if justice is to be done to both, the records of these examinations must be filed as confidential information under medical supervision and responsibility. Only the results of the examination, expressed in code form, should be filed with the employment record.

### MEDICAL SERVICE FOR THE SMALLER INDUSTRIAL PLANTS

According to the 1929 report of the Bureau of Census, there were 5,481,763 people in this country employed in 208,241 manufacturing establishments, each having anywhere from 1 to 500 employees. It is realized that it is this group of smaller plants that lack adequate medical service, particularly in its preventive phase. It is also realized that it is economically impractical for many of the smaller establishments to maintain medical departments within their own plants. The answer to this problem, then, seems to be "group service." In this plan for group service physicians and surgeons who are qualified and interested in this type of work should provide the service for groups of industrial plants rather than for groups of industrial plants to band together and employ their doctor.

### PROGRESS IN INDUSTRIAL MEDICINE AND SURGERY

Considerable progress has been made by industrial medicine and safety during the past 10 years. The injury frequency rate in industry has declined 61 per cent in that period and the injury severity rate has been reduced 43 per cent, according to reports by the National Safety Council. The downward trend of the injury rates was interrupted slightly in 1933 and 1934 when renewed industrial activity and an influx of untrained labor recruits brought about a slight increase in the rates. The 1935 injury rates, however, have established a new low point. Attention should again be directed to the fact that good medical and surgical service has been responsible for approximately one-third of this reduction in injury rates.

### ACCIDENTAL DEATHS

There were 16,500 occupational deaths in 1935 as compared with 16,000 in 1934. Death totals as caused by types of accidents, number of disabling injuries, and the related costs are given in Table I as reported by the National Safety Council.

### SEVEN PRIMARY CAUSES OF DEATH IN THE UNITED STATES IN 1934

The latest reports from the Bureau of the Census (Table II) shows accidents in third place in the order of importance as a cause of death per 100,000 population. Only heart disease and cancer exceed accidents as a primary cause of death.

### WORKMEN'S COMPENSATION LAWS

All states have enacted workmen's compensation laws with the exception of Mississippi and Arkansas. In 20 states and the District of Co-

lumbia disabilities resulting from occupational diseases are recognized as being compensable. The courts of some states have interpreted the term "injury" to include occupational diseases, but the present trend is to provide blanket coverage for occupational diseases by special enactments.

The blanket type of occupational disease law, which provides for adequate medical control in its administration, is preferable to the schedule type of law in which only disabilities arising from scheduled or listed diseases are compensable. There is no doubt that all states having workmen's compensation laws will eventually recognize occupational diseases in the same light as they do occupational injuries.

CERTIFICATE OF APPROVAL

Splendid co-operation has been extended to the College by various industrial organizations in conducting this campaign to improve medical and surgical service in industry. This response is most encouraging. To those industrial establishments in which the medical service is fully approved and is of such a nature as to give reasonable assurance of continued compliance with the Minimum Standard, a Certificate of Approval is granted. In order that this Certificate of Approval may always be significant of "adequate care of the health of the industrial worker," care will be exercised at all times to insure that such certificates are awarded only to the industrial medical services that merit such recognition.

# SYMPOSIUM: TREATMENT OF FRACTURES

## THE MANAGEMENT OF FRACTURE DISLOCATIONS OF THE VERTEBRAE ASSOCIATED WITH SPINAL CORD INJURIES

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MODERN life has been responsible for an appalling increase in the number of accidents, of which fracture dislocations of the spine are among the most serious. Each year to the vertebral injuries incident to occupational hazards are added those incurred in the more strenuous athletic sports, as football, diving, and riding, women as well as men contributing their share.

Vertebral injuries in which the spinal cord has escaped present an entirely different problem and permit of much simpler therapeutic measures than those in which the cord and nerve roots are involved. With such involvement the outlook as to life and function becomes at once far more serious and the demands upon the surgeon far more exacting and complicated.

That prompt recognition of the problem involved and rational and conservative methods of treatment can accomplish much under these circumstances is attested by the fact that, even with a growing accident rate, fatalities due to spinal cord injuries have gradually diminished.

*Mechanism and nature of vertebral fracture dislocations.* Injury to the vertebræ may be the result of direct violence or of indirect violence transmitted through the skull or the sacrum and pelvis. Vertebral injuries due to direct violence are rare. A blow by a jimmy or similar force may cause a fracture of the laminæ, but such injuries are so seldom seen as to be almost negligible, and their treatment is quite simple. Injury by indirect violence is more common. The effect of indirect violence upon the vertebræ is dependent upon two groups of variable factors: the one includes the architecture of the vertebræ, their mobility, and that of the supporting structures, as the ribs; the second has to do with the blow, its force, direction, duration, and point of impact.

The architecture of the vertebræ determines to a large extent the effect of the blow. Each vertebra consists of two parts differing in structure and reacting differently under the force of impact: (1) the anterior cancellous, relatively soft body, and (2) the more compact dorsal or neural arch and articulating processes. Of these two pillars the latter is the stronger and more resistant; the former bears the brunt of the injury. Difference in structure, however, is not alone responsible for the greater susceptibility of the vertebral body to compression. A second factor is the compound nature of the spine as an articulated column in which the mobile cervical and lumbar curves are the regions of least resistance (Fig. 1). Since the more common point of impact is in front of the center of gravity, the majority of blows produce extreme flexion. Indirect violence applied to either end of the vertebral column tends to produce flexion of the trunk with transmission of the greatest violence to the ventral less compact cancellous part of the vertebræ. Still another factor is the occurrence of automatic postural reflexes from the vestibular mechanisms, which tend to bring about flexion of the head and trunk, thus enhancing the anatomical tendency in this direction.

Blows applied anterior to the vertebral axis, as on the forehead and face, may cause extension of the cervical region; those applied to the shoulders or pelvis lead to extension of the lumbar region. Extension is the mechanism usually responsible for fracture dislocation of the odontoid process of the axis and for comminuted fractures of the lumbar spine in which the ventral ends of the vertebra are separated instead of compressed and wedge-shaped. Extension fracture is rare.

In flexion compression fracture part of the compressed vertebral body may protrude into the vertebral canal, causing injury to the cord, or displacement of the vertebral body may occur, in which case fracture of the articulating processes, usually of the tips, is seen, with tearing of the articular ligaments.

In addition to a simple compression fracture, comminution of the margins of one or both of the adjacent vertebral bodies may occur, with dis-

Presented in the Fracture Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

placement and tilting of the fragments, which may make reduction difficult and be an additional source of trauma to the nervous structures (Fig. 3). Especially is this true if comminution and separation of the fragments take place along the dorsal or lateral borders, since these fragments impinge upon the vertebral canal, materially narrowing it, or upon the intervertebral foramina, with compression of one or more nerve roots. The dorsal and lateral fragments are displaced more readily than the ventral because of the fact that the dorsal ligament is narrower and its attachment to the vertebral body far less powerful than that of the ventral ligament.

With fracture of the vertebral body and the articulating processes, the intervertebral disc is usually damaged and atrophy eventually occurs, especially along the ventral margin, with some angulation of the vertebræ. Juxtaposition of the ventral borders permits the development of an anterior bridge of callus leading subsequently to bony fusion. For this reason the degree of angulation must be controlled until such time as union is complete (Fig. 4).

The bony injury thus includes compression of the body and disc with or without fragmentation of the adjacent ventral and dorsal margins, fracture of the articulating processes, tearing of the articular ligaments, and usually displacement of the vertebral body. The direction of the displacement, as has been stated, is dependent upon a number of factors.

While it is held that injury to the spinal cord may occur as the result of sudden sharp flexion which produces compression of the vertebral body without apparent displacement, or with displacement which is spontaneously reduced, the majority of cord injuries are due to recognizable vertebral displacements.

*Level of injury.* There are three levels at which vertebral fracture dislocations occur most commonly. These are the three most mobile regions of the spine, namely: cervical 1-2, cervical 4, 5, 6, 7; and thoracic 11-12, lumbar 1, 2, 3 (Fig. 5). In the cervical region cervical 5, 6 are most frequently involved, and in the thoraco-lumbar region thoracic 12 and lumbar 1. Of all vertebral fractures, those of cervical 1 and 2 and cervical 7 are the most frequently overlooked, due primarily to the fact that the usual x-ray plate does not adequately show the first cervical vertebra and the odontoid process, while the seventh cervical is often not included in lateral views of the cervical region nor does it appear in plates of the thoracic region (Fig. 6). Unless effort is made to bring the seventh cervical vertebra into view by downward traction on the shoulders and arms, fracture in this location may easily escape the examiners. No study of suspected fracture of the cervical vertebræ is adequate unless these two areas be brought into view.

*Relative size of the spinal cord, vertebral canal and rôle of the fluid buffer.* In the event of vertebral displacement, the extent of the displacement and the violence of the injury are the two important factors determining the degree of spinal cord damage. Since the dura and surrounding epidural fat, the column of fluid which surrounds the cord, as well as the cord itself, lie within the vertebral canal, a certain degree of vertebral dislocation can take place and yet leave room for the cord, which would not be possible were it not for the fluid buffer and extra space.

Unfortunately, however, the ventrodorsal dimensions of the vertebral canal in both the cervical and lumbar regions are less than the lateral, and it is in the former smaller plane that displacements occur.

While the relative difference in the size of the vertebral canal and spinal cord would appear to afford a margin of safety, this is reduced, if not altogether eliminated, by the immediate hemorrhage and edema coincident with traumatism. Slight overriding of the vertebræ, however, does not necessarily mean destructive compression of the cord, and in the later stages is not incompatible with satisfactory cord function. It is, of course, to be remembered that the spinal cord ends at the lower margin of the body of the first lumbar vertebra, and that fracture dislocations below this level endanger not the spinal cord but the cauda equina. The latter occupies less space than the cord; damage to the nerve roots here is less destructive, and regeneration may take place.

*Changes in the cord following fracture dislocations.* The immediate damage to the cord at the site of the injury includes laceration, hemorrhage, and edema. Probably all three are present in varying degrees, depending upon the extent of the trauma. Since regeneration of the spinal cord does not take place, laceration causes permanent damage to the cord substance with degeneration of the ascending and descending tracts (Fig. 7).

Hemorrhage may occur within the substance of the cord with relatively little laceration, due to the direct impact of the displaced vertebræ. The hemorrhage is usually most extensive in the central gray matter; it may, however, occur as minute extravasations producing a generalized mottled appearance over several spinal segments both above and below the site of injury. Some extradural hemorrhage also takes place, but this is not

an important factor in cord compression. Under tension extradural hemorrhage may extend through the intervertebral foramina into the surrounding tissues or between the dura and bone a considerable distance above and below the level of injury.

Edema of the spinal cord takes place immediately and extends over a number of segments above and below the level of injury. It may be sufficient to interrupt temporarily all cord function, which gradually returns as the edema subsides, provided the latter has not been of too long duration. It is probably edema which is responsible for so called "spinal shock." Compression of the cord from this cause can be diminished by the measures used to overcome cerebral edema, namely, fluid intake and hypertonic solutions, such as 25 per cent glucose.

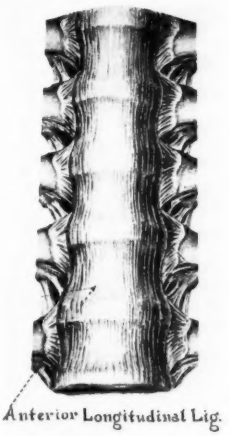
*Value of spinal manometric examination.* Since edema and hemorrhage into the cord and extradural hemorrhage all produce an obstruction of the subarachnoid space, manometric examination is of relatively little value in the differential diagnosis of cord compression by bone displacement, or as an indication for laminectomy or other form of treatment.

*Immediate clinical signs of spinal cord injury.* The immediate signs of spinal cord injury are those of complete interruption of conduction with loss of all motion and sensation and a level lesion more or less transverse but varying a segment or two depending upon the degree and nature of the damage at the site of the vertebral dislocation. Since edema and hemorrhage usually extend several segments higher than the level of maximum injury, slight segmental variations in the clinical signs may be found within a few days at the level of the injury while the signs below remain unchanged. This should not be taken as an indication of returning function at or below the actual cord injury.

In the early stages, all reflexes—both deep and superficial—at and below the level of the lesion are abolished. Hypotonia, retention of urine and feces, priapism from venous engorgement, abolition of sweating, and vasomotor paralysis occur.

The total abolition of cord function seen immediately after injury and persisting for days or weeks, or even longer, has been attributed in part to so called "spinal shock," but anatomically is probably due to cord edema.

Whether the cord is severely lacerated or only slightly traumatized and edematous, the clinical signs in the early stages are essentially the same. Hence, at first—the severity of the lesion cannot be determined, or whether it be due to irremediable structural changes or merely to edema. At this stage, so far as the clinical signs are concerned, there are no criteria to indicate the probable outcome.



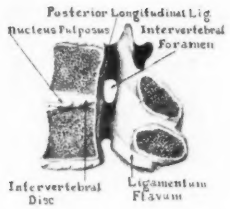




Fig. 1. Anatomical structure of the vertebræ showing the cancellous bone of the anterior portion and the powerful anterior longitudinal ligament. Upon the strength and firm attachments of the latter structure all methods of reduction by hyperextension are based. Modified after Sobotta.

After the early effects of the injury have passed off and absorption of edema and blood has taken place, at least in part, the reflexes are re-established. Flexion or extension of the toes on plantar stroking, slight contraction of the hamstrings, beginning patellar and Achilles jerks make their appearance. Mass withdrawal reflexes, i.e. bilateral flexor spasms of the lower limbs and lower trunk, occur.

## TREATMENT OF FRACTURE DISLOCATION AND SPINAL CORD INJURY

*Immediate first aid.* Immediate recognition of spinal cord trauma, at the site of the accident, is imperative, since careless transportation may convert a relatively slight injury into an irremediable lesion. I have known of paralyzed patients being picked up and transported to the hospital by automobile, in an upright position, certainly jeopardizing whatever may have remained of spinal cord continuity. Since physicians are not always on hand to make an immediate diagnosis, the lay public must be instructed that any injured patient unable to move arms and legs, or legs alone, should not be moved until competent aid arrives. All too often a well meaning Good Samaritan will try to lift the patient and carry him to a more comfortable place, entirely ignorant of the fact that further flexion of the head on the trunk may result in severe and permanent damage to the spinal cord. Under these circumstances a few minutes in presumably greater comfort may mean

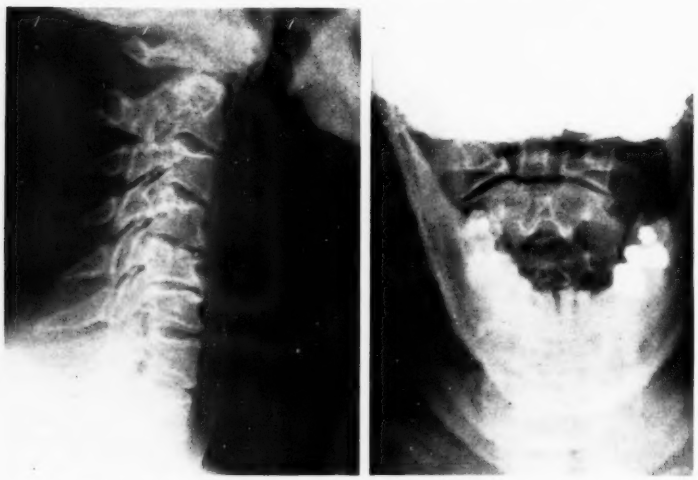


Fig. 2. Fracture of the odontoid process of the axis and forward displacement of the atlas.

a life time of paralysis. Another unfortunate procedure all too often seen in well meant attempts at first aid consists in lifting the patient's head to enable him to drink, thus bringing the chin onto the chest, which in the presence of a fracture dislocation of the cervical vertebræ may further destroy whatever cord function remains.

The immediate handling of fracture dislocation with spinal cord injury is so important that those who are likely to render first aid must be made aware of the dangers inherent in such accidents. A campaign of public education is imperative, that the layman may be informed on this subject just as he has been on the resuscitation of a drown-

Fig. 3, left. Ventral and dorsal displacement of fragments of the vertebral body. Knapp Print.

Fig. 4. Fusion of vertebral bodies and formation of ventral callus following fracture dislocation of fourth cervical vertebra.

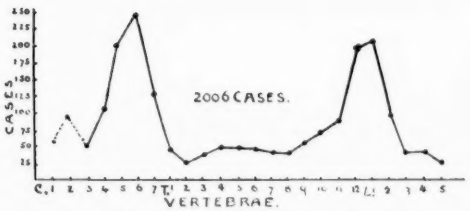



Fig. 5. Graph of the localization of spinal cord injury from 2006 cases in the literature. Note the critical points. From Jefferson, Proc. Roy. Soc. Med., 1928, vol. 21, Part 1.

ing man. It cannot be too strongly emphasized that these patients should be left alone or moved only under skilled direction.

Often, however, trained aid is not available. If the patient can move his *arms*, *hands*, and *fingers freely*, but unable to move his legs he may be rolled over face downward, without lifting, on the presumption that the lesion is in the thoracolumbar region, and then transported; if, however, both legs are paralyzed and the arms partially he must be moved most cautiously by three or four persons, one pulling on the head and one on the feet, exerting gentle traction only, not lifting, while the others carry him, lifting beneath the shoulders, trunk and hips. Only by such careful handling can further damage to the injured cord be avoided.

*Immediate x-ray from first aid stretcher without moving patient.* Once the patient has been properly placed on a stretcher, he should be carried immediately to the x-ray room, where lateral plates should be taken without moving him to a bed. After these plates have been developed, the nature of the injury determined, intelligent treatment can be undertaken. Even though the patient is in shock, a proper position permitting reduction will frequently improve the condition. Shock may often be treated adequately in a position which will help also in reduction of the fracture dislocation. This may not be the case, however, in the presence of cervical dislocations. Here, when the head is allowed to hang in hyperextension, breathing may be difficult, though as a rule, with reduction of the dislocation, this is more satisfactorily handled.

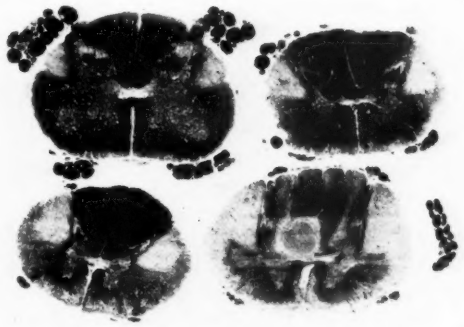


Fig. 7. Injury to cervical cord due to fracture dislocation of the cervical vertebræ. Weigert-Pal stain. Note hemorrhage in central portion of cervical region I (lower right) and degeneration of descending tracts, especially the pyramidal, in all segments below level of injury.

*Operative treatment.* Some form of operative interference is generally urged upon the surgeon,

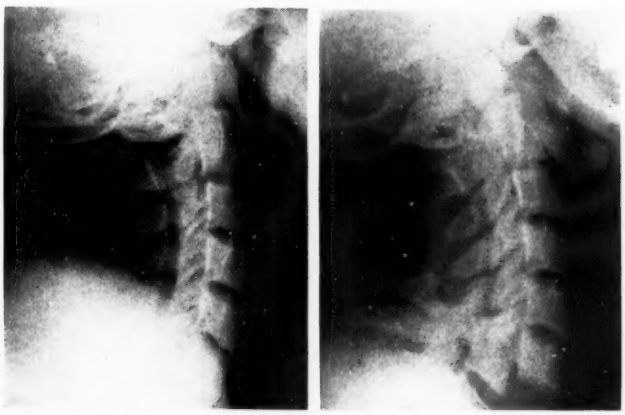


Fig. 6. Left, apparently normal cervical vertebræ. No evidence of fracture. Right, the same patient but the seventh cervical vertebra now showing.

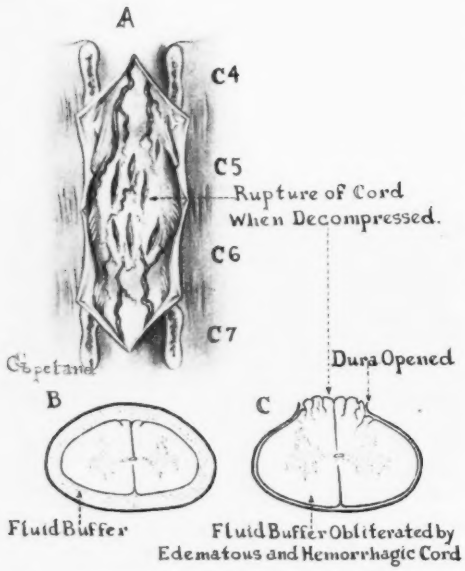



Fig. 8. A, Drawing to indicate swollen, edematous and hemorrhagic spinal cord at level of injury. When the dura was opened the cord was found ruptured, increasing the damage already done by fracture dislocation of the vertebræ. B, Indicates relative size of spinal cord and vertebral canal with the intervening fluid buffer. C, Dura opened, spinal cord decompressed extending through opened dura.

who must often exercise considerable courage to refuse. Laminectomy, except in most unusual circumstances, is in my opinion not justified, since reduction of the displaced vertebræ may be better accomplished by nonoperative methods especially in view of the likelihood of damage to the cord by working on its ventral surface. Furthermore, laminectomy removes much of the bony structure which is invaluable for stability of the vertebral column. An even more serious objection to open reduction is that an opening into the dura will allow the cord to extrude and permit rupture of whatever intact substance may remain, thus converting what may have been a partial anatomical injury into complete anatomical disruption (Fig. 8).

Occasionally, however, a fracture dislocation is not seen by the neurosurgeon until it has existed for some weeks, and peri-articular contractions and callus formation about the tip of the articulating processes have occurred to render closed methods of reduction unsuccessful. Under these conditions laminectomy is the only method available. The attempt should be, however, not to reduce the dislocation but rather simply to relieve compression of the cord and to allow it to be straightened. By removal of the dorsal arches of two vertebræ, the angulation of the cord will be corrected and compression removed. When this is done the dura should not be opened.

In these cases laminectomy is difficult, especially in the cervical region, since the head must be held on the table in hyperextension, whereas cervical laminectomies are usually done with the head in the hyperflexed position. Hyperextension tends to lock the arches, but with care the latter can be removed, in spite of the unfavorable position, without damage to the underlying cord. Where laminectomy is done under these conditions, care should be taken not to remove the laminæ too widely and to avoid the articulating facets, since these serve as points of fixation, and it is here that fusion of the vertebræ must take place in the absence of the spines and laminæ.

*Non-operative treatment.* When fracture dislocation of the vertebra in the cervical region is complete, as it frequently is, the articulating facets of the one vertebra are found to have slipped above and behind the vertebra below. Under these conditions hyperextension alone, without traction, serves only to increase the deformity and the pressure upon the cord. The method of choice in such cases is first traction with gentle flexion, followed by hyperextension after the articulating facets have unlocked.

The procedure worked out and developed by Alfred S. Taylor, in 1911, is in my opinion the best method of reduction for cervical dislocation. It has been my privilege to work with Dr. Taylor on a number of cases and to him I owe much of the information and training which have made this paper possible.

*Alfred S. Taylor's method of reduction of cervical dislocations.* The principle of Dr. Taylor's method is controlled traction of the head with counter traction on the lower extremities. The traction is exerted through a rope snugly fixed about the operator's hips by a backward movement of his trunk, thus leaving the hands free for bimanual manipulation of the neck as desired. The procedure step by step, is as follows:

Step 1. No anesthesia is used. In the presence of cervical fractures respiration is frequently difficult and any further embarrassment may become a serious complication. Morphine depresses respiration and for this reason is also contraindicated.

In placing the patient upon the table, traction on the head and counter traction upon the extremities should be maintained. Reduction should

A

C

B

Fig. 9. Photographs to show Alfred S. Taylor's method of reduction of cervical dislocations. A and B, Halter of folded moleskin adhesive or ordinary adhesive is made so as to fasten to rope or belt passed over a folded blanket about the surgeon's hips. Traction is made by the backward movement of the surgeon's trunk, the hands are freed to manipulate the head and neck. C, Countertraction is made by fastening rope and pulley to the ankles.

be done in the x-ray room or where a portable x-ray is available so that lateral pictures can be taken during the process of reduction and the cast applied only after the latter has been satisfactorily accomplished. A Hawley table is preferable so that counter traction can be exerted upon the lower extremities. However, if a Hawley table is not available an x-ray table or any other table may be used by placing along its length a small metal strip 4 inches by ½ inch, extending far enough along the head of the table to reach the second thoracic vertebra. A small upright pipe resting upon the floor will be adequate to support the strip, to which it may be fastened by the aid of adhesive or by screwing it into the metal strip.

Step 2. A halter made of two layers of folded moleskin is placed over the patient's occiput and beneath the chin, and fastened over the temporal region with 3 or 4 safety pins, the moleskin being drawn tight enough so that it will not slip. A small piece of felt is placed beneath the chin so that the halter can be withdrawn easily when the cast is applied and to serve as protection from the cast. Moleskin adhesive is preferred to the usual leather halter since it occupies less space and can be easily slipped out after reduction has been accomplished and the cast applied without impairing the snugness of the latter about the chin. A piece of soft rubber a half inch thick inserted in the mouth to serve as a bite for the teeth will add to the patient's comfort. This should be made wide enough to reach the teeth on both sides of the jaw, as well as in front, and be long enough to protrude from the mouth and be easily removed if respiration becomes difficult.

Step 3. A rope or strong belt is then passed around the surgeon's trunk over a folded blanket and tied to the ends of the halter about the patient's head. If an old rope is used, it should have been well stretched so that there will be no give during the process of reduction. The tie to the halter should be made as close as possible to the surgeon's body, otherwise he will find himself working at arm's length instead of with his hands fairly close to the patient's head, thus making manual manipulations difficult (Fig. 9).

Step 4. With the table and the patient and the surgeon thus arranged, and all preparations ready for application of a plaster jacket, reduction of the fracture dislocation is begun first by gentle but continuous traction in slight flexion so as to unlock the overriding articulating facets. When these have been unlocked and the superior articulating facet brought back in front of the inferior one, the direction of traction is changed to hyperextension and complete reduction is accomplished.

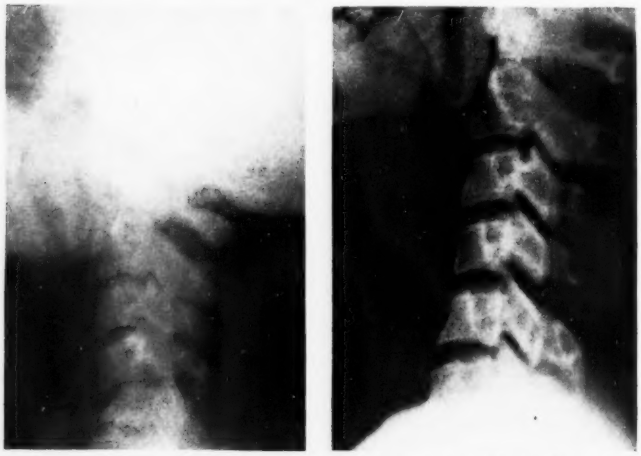


Fig. 10. Left, Fracture dislocation of fourth cervical vertebra before reduction. Complete paralysis below level of lesion. Right, The same after reduction by Alfred S. Taylor's method. Patient entirely symptom free and leading active life.

When reduction is satisfactory, as shown by x-ray plates, a plaster cast is applied extending from the hips to the occiput and chin. The most important part of this jacket is that which supports the chin and maintains the head in hyperextension. This part should be padded with small strips of felt—not so thick as to interfere with adequate molding of plaster about chin and occiput.

The Taylor method in complete fracture dislocations is by far the best method which I have used. I have, however, had no experience with the tongs which were suggested first by Crutchfield, later by Kenneth McKenzie of Toronto.

Crutchfield applied Edmonton tongs, from which the sharp points had been removed, to the parietal eminences exerting traction, using 4 pounds, after placing the patient upon a Bradford frame. Traction was increased daily until a maximum of 9 pounds had been applied. This was maintained for 36 days. Crutchfield's case was a forward dislocation of the second cervical on the third cervical. Judging by the illustrations which he shows as the final result, little change had occurred in the relative position of the displaced vertebra. Practically the whole of the body of the second cervical remained anterior to the third cervical. This patient was seen immediately after the accident and the apparatus applied within a few days of the dislocation. Crutchfield has developed a more efficient appliance and his latter results are very satisfactory.

*Air cushion reduction.* Where fracture dislocations are incomplete, reduction may be accomplished by what I have termed air cushion reduction in hyperextension. The method can be used immediately after the injury, can be maintained as long as may be desired, and is available in any hospital having an air mattress. Reduction of the dislocation is accomplished without manipulation and usually demands no special skill. In the cervical region the principle involved is gradual and continuous overstretching of the neck musculature with the head dependent and the neck in hyperextension. This is accomplished by bending the head end of an air mattress acutely over a blanket roll (Fig. 11), with the aid of a strip of adhesive attached to the mattress at the level of the roll, pulled down tightly, and fastened to the bed. Within a few hours the muscles are completely relaxed and reduction takes place.

The same principle of acute angulation may be applied to any part of the spine by altering the position of the adhesive and the blanket roll beneath the air mattress. The method is thus applicable to compression fractures of the spine wherever hyperextension is desired. Air cushion hyperextension is preferable in most cases to the use of the canvas covered Bradford frame or its modifications. The degree of hyperextension may be varied by altering the size of the blanket roll, and the level of hyperextension by changing its position. With slight modifications this method may also be used in the transportation of patients with acute spinal cord injuries, a stretcher being sub-

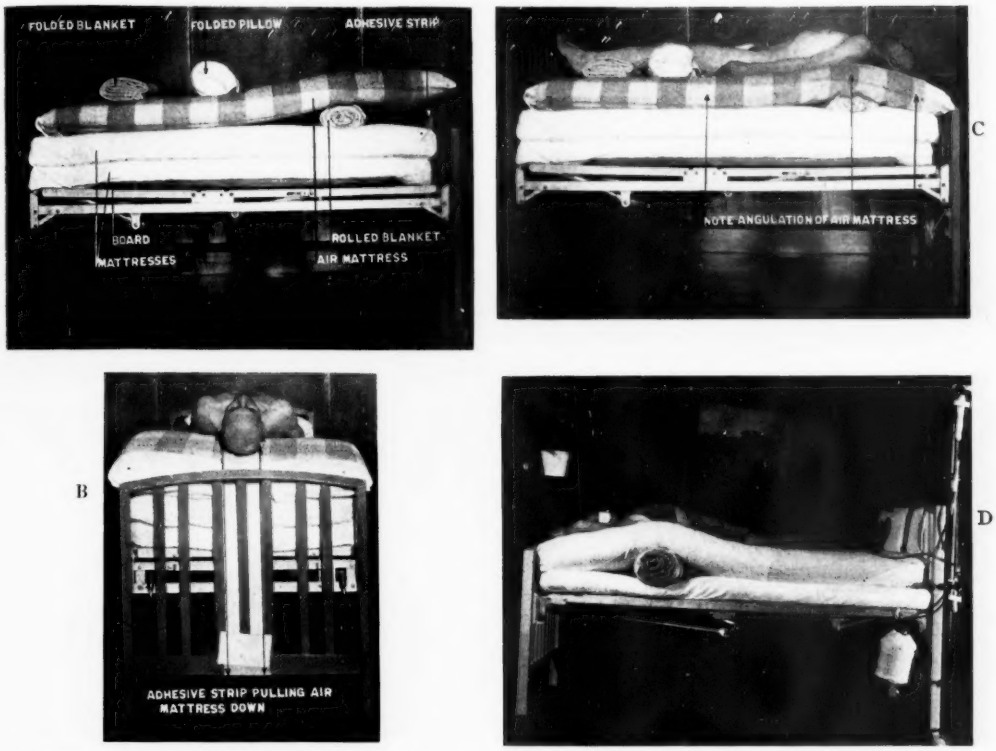



Fig. 11 A, Arrangement of bed for air cushion reduction. The foot end of the bed is made the head end in order to be able to get at the patient's head. B, Air mattress head down with 8-inch adhesive strip to form angulation of mattress and bring the neck into hyperextension. C, Patient in position for reduction of cervical dislocation. D, The patient in position on air mattress for reduction of lumbar dislocation.

stituted for the bed. If an acutely injured patient is placed immediately upon an air mattress and stretcher, further injury of the spinal cord in moving is avoided and pressure is minimized. The patient is in hyperextension and in a position to favor reduction even while being transported and prepared for roentgenography and subsequent care. As has been pointed out, inept handling of fracture dislocations in the process of transportation may further displace the vertebral fragments and increase the injury to the spinal cord.

The technique of the air cushion reduction method is as follows:

1. A fracture board is placed on the springs in the usual manner. The foot of the bed is placed on low blocks to elevate it slightly, as it is to be used as the head end and the position of the patient's head is thus raised in relation to the trunk.

2. Two ordinary mattresses are placed over the fracture board to raise the level of the patient's head above, or at least level with the top of the foot piece (Fig. 11).

3. A blanket is rolled and placed upon the ordinary mattresses at the level of the shoulders if the fracture dislocation involves the cervical vertebræ or at whatever level may be indicated for other regions of the spine.

4. An air mattress, preferably 8 inches thick (a thinner air mattress is unsatisfactory), is then placed upon the bed over the blanket roll and a strip of adhesive—8 inches wide if fracture is in cervical region, 12 to 14 inches for fractures in thoracic or lumbar region—is applied to the mattress beginning at the line of the blanket roll.[1]

5. The mattress is covered with a soft woolen blanket or a sheet, if preferred, and the patient is

[1]The description given is suitable for any air mattress. However, a special air mattress has been developed by the author for this method which has all attachments necessary to hold the mattress over a blanket roll and also a middle section which can be deflated so as to allow easy access to the buttocks without shifting the position of the patient in using a bed pan.

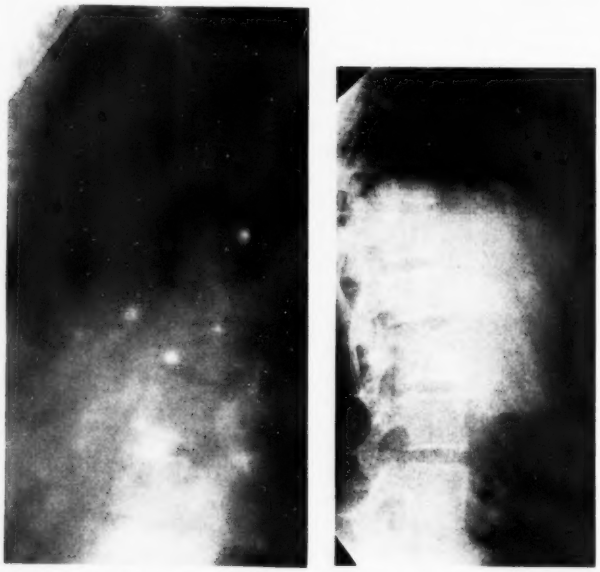
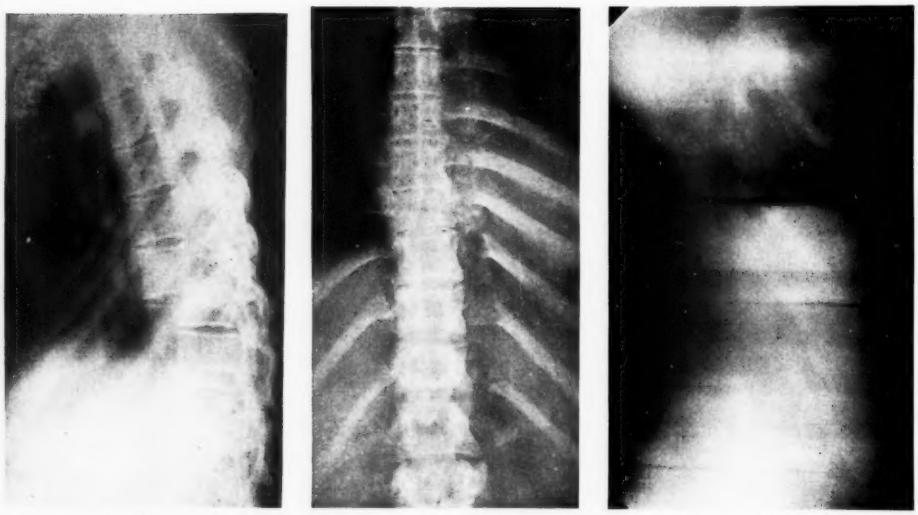


Fig. 12. Left, Compression fracture of first lumbar vertebra before reduction. Right, After reduction by air cushion method. Patient now walking.



A B C

Fig. 13. Severe disruption of vertebral column at ninth thoracic and second lumbar. Fall from second story—multiple fractures of ribs. A and B, before reduction; C, after air cushion reduction.

then placed on the bed. A soft woolen blanket absorbs moisture and in my experience has been found more comfortable for the patient than a sheet.

6. The adhesive is then drawn as tightly as possible, with as much force as is necessary to obtain the proper degree of angulation of the air mattress, and is either fastened directly to the bottom of the foot piece of the bed or to a movable bar attached to the foot end, a ratchet being used to tighten it as needed. The air mattress must be kept pumped up, and the adhesive must be tight at all times.

7. A pillow is then rolled and placed beneath the patient's knee so as to flex the lower extremities slightly. A small folded blanket is placed beneath the calf muscles reaching to within 4 inches of the insertion of the tendon of Achilles. With the calves resting on a wide surface, the heels are kept off the bed and pressure sores are avoided.

Any abnormal position of this sort is naturally uncomfortable and I have found codein and luminal advisable to relieve the discomfort during the first few days. As the patient becomes accustomed to his position, the drugs may be discontinued.

If each of the details is carefully observed I believe that this method will be found satisfactory for the reduction of incomplete vertebral fracture dislocations, especially in the cervical region, and for the reduction of compression fractures of the entire spine. Its simplicity and availability, wherever an air mattress is to be had, are additional factors to commend it both as a temporary and prolonged means of reduction, as well as for transportation in the presence of acute injuries of the spinal cord associated with fracture dislocations of the vertebræ.

*General treatment.* In treating a patient with fracture dislocation and spinal cord injury many difficulties arise which are not present when the injury involves the bony structure alone. With paralysis of both lower extremities or of all four extremities, and loss of visceral function, the problem is indeed complicated, while the patient's mental attitude is frequently, and quite naturally, one of hopelessness. To meet the situation thus presented much skill and ingenuity are required.

*Supportive treatment.* Since the patient will probably be bedridden and shut-in for many months, measures must be instituted immediately to build up the general condition. Viosterol or its equivalent should be given and the patient must be induced to eat sufficient to maintain or increase his weight, as loss of weight removes the subcutaneous fat serving as padding about the sacrum and pelvis, which is so important in the prevention of bed sores. The diet should be high in vitamins. Whenever possible the bed should be so placed that it can be rolled out onto an open veranda. The blood picture should be followed and liver or other blood stimulants given, as indicated.

*Complications.* The most serious complications are trophic sores, bladder and kidney infections, and gastro-intestinal disturbances.

*Trophic disturbances.* I know of no nursing problem requiring greater skill and more constant attention than that presented in the treatment of spinal cord injuries. The arrangement of the bed has already been described. Whatever method of reduction is employed, it is essential to have a good air mattress, to avoid all wrinkles of sheet and rubber pad, and to protect the buttocks and heels from pressure.

It has been difficult to obtain a suitable air mattress. Many of these are made in longitudinal or transverse sections which produce a more or less corduroy effect, and because of their unevenness and hardness are unsuitable in the treatment of acute spinal cord injuries. I have recently developed a special mattress for the management of these cases which has proved highly satisfactory. It is approximately 8 inches thick, is lightly tufted, and contains no ridges. A special air mattress has also been designed consisting of three joined sections, the center one of which can be deflated to allow the insertion of a bed pan and care of the perianal region. A description of these mattresses has been published elsewhere.

A folded pillow may be kept under the knees, and a small folded blanket beneath the calves of the legs of sufficient thickness to prevent the heels from resting upon the bed, as described above. This blanket must never be allowed to reach beyond a point one inch above the malleoli. In my opinion, the so called doughnuts of cotton and bandage which are used to raise the heels from the bed are inadequate. The folded blanket is more satisfactory and is always available.

Foot drop must be avoided by building up the foot of the bed by a foot board with an extension to form a support for a pillow against the foot board, the pillow being fastened in such manner that it is kept in a fixed position and all wrinkles are eliminated. One or two small baby pillows may be used to make slight adjustments of the position of the feet.

The patient's legs and arms should be put through passive movements designed to maintain the normal range of each joint and also to alter the position of the buttocks and sacrum on the

bed. These movements must be done frequently during the day if contractions are to be avoided and if the circulation is to be maintained.

The circulation of the skin over the buttocks may be increased by placing one hand on the air mattress, pressing down beneath one buttock, and using the other hand to pull the skin of the buttock gently upward, thus alternately raising and letting the buttock fall. The same method may be applied to the region of the sacrum. By pressing the air mattress down, away from the sacrum, and pulling and relaxing the skin over the side of the hip, the circulation of this important area can be improved.

To keep the skin of the back, buttocks, and sacrum clean a soft piece of cotton flannel, approximately 4 inches wide and 24 inches long, may be passed beneath the back, and pulled gently from side to side. A very small amount of fine powder may be placed on the cloth if desired, but an excess of powder should be avoided. This strip is very much like the scratcher used under a cast but must be very gently manipulated.

*Care of bladder.* The avoidance of bladder and kidney infection is perhaps the most important factor in the patient's care. Bladder infection almost invariably leads to kidney infection, and the latter to high temperature, vomiting, nausea, and retardation of returning cord function. I have seen restored spinal cord function temporarily lost again during an episode of bladder and kidney infection, and the same may be true of gastro-intestinal upsets.

Various methods have been tried, among them the so-called "automatic bladder" which, in my experience, has not been satisfactory since it allows residual urine and permits a paralyzed bladder to become overstretched, with consequent backing of the urine into the ureters. I no longer use this method. Perhaps the most satisfactory measure is the use of an indwelling catheter, which is changed every 5 to 6 days and is allowed to remain out of the urethra during an 8-hour period. With this the bladder is emptied *regularly* every 8 hours. Bladder irrigations are carried out daily with some antiseptic solution and methyolate is instilled once or twice a day.

Another method which has been used satisfactorily is the suprapubic cystotomy with a fixed permanent indwelling catheter through which the bladder can be cleaned and antiseptic solution instilled. While I have had no experience with this procedure, it has been successfully employed by the late Charles Dowman of Atlanta and has received his enthusiastic support.

A method which I have recently used is that developed by Donald Munro of Boston, called "tidal drainage." While the results have not always been entirely satisfactory, since the fluid in a number of instances has not run into the bladder, I believe that with careful attention to the many details essential to proper functioning of the apparatus it should prove most useful. Certainly when this method has been perfected by its originator, it will be of immense value.

In all patients I consider it desirable to have the perianal region and vulva shaved, as this permits of cleaner handling. Excessive use of powder is undesirable; only sufficient should be used to cover the skin lightly, as it is always bad practice to allow powder to accumulate in the bed. Any soiling of the bedding must be immediately taken care of and the skin washed with alcohol, but no moisture must be permitted to remain about the perineum or buttocks.

*Management of the intestinal tract.* It is to be recalled that the gut is paralyzed, as well as the extremities, and that abdominal distention and constipation must be overcome. All patients should receive acidophilus milk or acidophilus cultures throughout the period of illness, as this minimizes gastro-intestinal intoxication and facilitates the care of the bowels. With diminution of intestinal intoxication, toxic absorption from the gut is minimized and the additional strain of such absorption upon the already weakened kidneys is lessened.

Care must be taken in giving enemas and irrigations since the gut will readily distend if too much fluid is used. Because of this, all fluid given must be measured and the return likewise measured. The diet should be regulated to avoid too much roughage. It should be sufficiently rich, and, as suggested, the patient should be encouraged to put on weight since additional pounds serve as extra padding and a preventive of bed sores. When cathartics are given, watery stools should be avoided, the aim being to have the evacuations neither too soft nor too hard. It must be remembered that the external sphincter is a voluntary muscle and does lose tone, whereas, the internal sphincter is an involuntary muscle and, though it may retain a certain amount of tone, is not strong enough to hold fluids.

*Psychic factors.* It must be recognized that a long chronic illness lies ahead and that the patient's courage may reach a low ebb. Everything must be done, therefore to build up his determination and morale. To this end a cheerful room should be selected, and friends should be encouraged to make short visits. Mirrors may be placed over the patient's head so that the entrance

to the room may be observed and glimpses of the outside world obtained. Periscopic glasses have been developed to make reading possible and an overhead glass may be arranged on which to place a book. The radio will do much to vary the monotony of the sick room and such devices as an outside feeding cage for birds or a tank of fish will add interest to life. Nothing should be neglected which will bring cheer and courage to patients sorely in need of help.

SUMMARY

1. Vertebral fracture dislocations occur usually as the result of indirect violence, and the body of the vertebra as a rule bears the brunt of the injury. The regions most commonly involved are (1) cervical vertebræ 1-2; (2) cervical vertebræ 4-7; (3) thoracic vertebræ 11-12 and lumbar vertebræ 1-2.

2. Damage to the spinal cord is dependent upon the extent of vertebral displacement and the violence of the injury though not necessarily in proportion to displacement. It consists in spinal shock, edema, hemorrhage, and laceration.

3. The first consideration in treatment is the immediate handling of the injured patient. This should be done only under skilled direction and any further flexion of the injured cord should be avoided.

4. The lay public must be instructed to recognize paralysis of the arms and legs and the danger of further damage in handling these patients.

5. X-ray plates should be made as the patient is brought into the hospital and while still on the stretcher to determine the location and extent of the injury in order that intelligent treatment may be given.

6. Laminectomy is contra-indicated except under unusual conditions.

7. Dr. Alfred S. Taylor's method based on controlled traction and counter traction has been found to be most useful for complete cervical dislocations and is described step by step.

9. For incomplete fracture dislocations in this region and for compression fractures at any level the author's air-cushion method of reduction in hyperextension gives good results, is simple and easily carried out. It is described in detail.

8. The Crutchfield-McKenzie technique is also described.

10. The general supportive treatment is outlined and measures for the prevention and treatment of trophic disturbances, bladder, kidney, and gastro-intestinal complications are suggested.

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# FRACTURE OF THE HIP JOINT

## Treatment by Extra-Articular Fixation with Adjustable Nails

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FRACTURE of the neck of the femur is the most serious of all fractures involving joints. The mortality rate is high and the percentage of poor results is distressing. These fractures may occur at any age, but are most frequent in the latter decades of life. The age of greatest incidence is between the years of 50 and 60. Patients with intertrochanteric fractures average 5 to 10 years older than those with fractures through the narrow part of the neck.

### TYPES OF FRACTURES

Various detailed classifications may be found in the literature, but these only add to the confusion. The two great divisions are simply: fractures through the neck of the femur and fractures through the intertrochanteric region. Fractures through the neck are always intracapsular; fractures through the base of the neck may be partly intracapsular and partly extracapsular. Intertrochanteric fractures are mainly extracapsular, although a line of fracture may extend into the hip joint. Subcapital, transverse cervical, oblique cervical, intracapsular, basilar, adduction, and abduction fractures are all subdivisions of fractures of the femoral neck. Comminuted fractures of the upper end of the shaft, pertrochanteric, intertrochanteric, transtrochanteric, and extracapsular fractures are subdivisions of intertrochanteric fractures.

Absorption of the neck, fibrous union, and non-union have commonly occurred following fracture of the femoral neck. The cause of non-union was felt to be due to the fact that the fracture was intracapsular and had a very poor blood supply. Recently it has been determined that there is a very good blood supply to the head, coming up from the shaft and trochanteric region; and also, a considerable blood supply is furnished by way of the ligamentum teres. The nearer a fracture is to the head, the poorer is the blood supply; this explains why subcapital fractures are more prone to non-union than are fractures through the base of the neck.

Another factor of great importance is that mechanically it is more difficult to maintain apposition in a subcapital fracture than it is in a basilar one. Healing of these fractures is governed by the rules of hyperemic decalcification and ischemic recalcification. When the fragments are imperfectly immobilized, the trauma of motion gives rise to increased and continued hyperemic decalcification, with absorption of the neck and non-union. In subcapital fractures with non-union, the neck is absorbed because the main source of blood supply comes up from the distal fragment, and hyperemic decalcification takes place there. The head in such fractures may be almost entirely avascular; there is no absorption of its calcium content, and it shows up in the x-ray film as a dense, hard sequestrum, as compared with the surrounding osteoporotic bone. When it is possible to reduce the fragments accurately and to maintain perfectly this accurate reduction, there is no physiological reason why union could not be expected as well in fractures of this region as in other parts of the body of any given patient. If the blood supply can be increased by the drilling of holes up through the neck and into the head, one should be even more certain that union will occur. Casts, traction splints, or any other type of external appliance cannot maintain apposition perfectly; it is necessary to do some form of operation with internal fixation, if union is to be expected. In contrast to femoral neck fracture, the intertrochanteric region is rich in blood supply, and fractures through this locality always heal well. Even in the presence of poor position, solid bony union usually results.

### AGE AND SEX

These fractures occur rarely in childhood, occasionally in young adults, not infrequently during middle life, often in elderly individuals, and very frequently in the aged. Women are more frequently affected than men. There are certain physiological and mechanical reasons for this. With advancing years, the entire bony framework becomes more brittle and osteoporotic. The neck of the femur is particularly affected in some patients, and there is absorption of bone, with replacement of fatty marrow, and thinning of the cortex. There has been considerable question as

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to whether this process is pathological. It is more likely that it is simply an exaggerated local change of the generalized osteoporosis incident to senility. That these cases can go on to good, solid union after fracture seems to bear out this opinion. Besides the brittleness of their bones, old people have slow reflexes and poor plastic muscular tone. A sudden strain may be transmitted with great shock to their bones and result in fracture. It was formerly thought that the femoral neck bent down farther on the shaft with increasing years, and that this reason explained mechanically the increased frequency of fractures in later life. This view has proved to be incorrect. The neck of the femur maintains its normal angle throughout life. The mechanical reasons for the increased number of fractures in females are: Normally the angle of the neck of the shaft is less; there is more of a coxa vara; and the neck is smaller and weaker in females than in males.

### TYPE OF TREATMENT

Statistics have shown that approximately 25 per cent of the patients with fracture of the hip joint die, and of the remaining cases, only about 50 per cent secure good bony union. This appalling situation creates a real challenge to try to improve on treatment that has been used in the past. The old dictum: "Treat the patient and disregard the fracture," is not good advice. The best way to treat the patient is to treat the fracture. As soon as the fracture is accurately immobilized pain is relieved and the patient has a much better chance to recover.

Various methods have been advocated to maintain accurate reduction and prevent prolonged recumbency in bed. Among the best known is the Whitman reduction and immobilization in the long abduction spica cast. Leadbetter has modified and improved this technique. But plaster casts cannot be used nor can they control reduction in all cases, and there is always a certain amount of atrophy and joint stiffness following prolonged immobilization in plaster. Atrophy in plaster undoubtedly explains many of the cases of non-union that result.

Conservative closed methods have the following disadvantages in most cases:

A. Some type of anesthesia is necessary.

B. Statistics show a high mortality.

C. A certain number will have permanent disability.

D. A certain number will be miserable and uncomfortable in the immobilizing cast or piece of apparatus.

E. Pressure sores may develop.

F. Prolonged immobilization or recumbency predisposes to atrophy of soft tissue and bone with possibly of: (a) absorption of the femoral head and neck; (b) non-union, or fibrous union; (c) various degrees of ankylosis in all joints of the extremity with disability resulting, even though the fracture heals in good position.

G. Weight bearing cannot be allowed for fully 6 months. The period of inactivity will average at least 9 months to a year.

H. Prolonged hospitalization, numerous x-ray examinations and other treatment, plus charges of physicians and special nurses make the treatment very expensive.

Various types of internal fixation and reconstructive operations have been advocated. Numerous types of bone pegs, grafts, steel screws, and nails have been used. Smith-Petersen has reported some splendid results with his specially prepared three flanged nail. But these operations have to be performed on selected cases and a massive hip joint exposure is necessary. The average old patient cannot safely undergo such a procedure. Westcott has worked out a very nice technique to secure the femoral head in place with a Smith-Petersen nail and uses only a small incision beneath the great trochanter. Johannson, White, and other operators have independently developed various modifications of this method and have reported excellent results. Gaenslen, Telson and Ransohoff, and others have inserted pins and wires under roentgen ray guidance without any incision whatever. While a great deal has been accomplished, no universally satisfactory method has been recognized.

### AUTHOR'S METHOD: USE OF 3 NAILS

I have developed a technique for handling these cases which I believe has certain distinct advantages. I began using this method in March, 1934, and now have 64 cases. It is true that a number of patients will die regardless of treatment. It is also true that certain other complications are inevitable; for as a rule the patients are old and are poor risks for any type of surgical undertaking. However, I feel that if they are able to stand any treatment at all, they are able to go through with this procedure. The manner in which some very desperate cases have improved after fixation has been startling. I have observed a number of cases in which infirmity seemed so great that the outlook appeared hopeless, but the patient stood the operation well and began to improve immediately afterward. I have not had a single case in which a serious reaction followed operation. The operation is not difficult, and it is

done entirely under local anesthesia. No complicated apparatus is necessary. Following closed reduction, an incision is made, and the head of the femur is secured in position by 3 small stainless steel nails in such a manner that the femur is practically as strong as it was before the fracture occurred. Permanent and accurate fixation of the fragments relieves pain and accounts for the immediate improvement following operation. No plaster splint or other retentive apparatus is necessary. Movement is allowed at once, and there is no resultant joint stiffness. The patient sits up in bed, or may be about in a wheel chair, soon after operation. In a few days he can be using crutches and may leave the hospital. The expense of hospitalization and nursing care is greatly reduced by this method.

*Technique.* The operation is performed in a regular operating room with a portable x-ray unit handy for checking on the position of reduction and the position of the nails after they are inserted. In hospitals in which a mobile x-ray unit is not available the operation may be done with the patient on a stretcher. This saves changing the patient from one table to another and makes easier the transfer to and from the x-ray room.

*Anesthetic.* A small dose of morphia or 3 to 6 grains of sodium amytal is usually given prior to operation. After the usual skin preparation (we shave, wash thoroughly with green soap and sterile water, then cleanse with ether, and paint with two coats of iodine), the hip joint is injected with 20 to 40 cubic centimeters of 2 per cent solution of novocain. The point of injection is easily determined. The highest point of the head of the femur lies underneath a point midway between the anterior superior spine of the ilium and the spine of the pubis. A line is drawn from the anterior superior spine to the spine of the pubis, and ¾ of an inch below the midpoint of this line the point of injection is established temporarily. One should be sure to palpate the femoral artery. It emerges from underneath the inguinal ligament just medial to its midpoint. The artery can be felt easily, even in a very obese patient, and care is taken to make the injection about ½ of an inch lateral to the femoral artery. The definite point of injection is now located, ½ of an inch lateral to the femoral artery and ¾ of an inch below the midpoint of the inguinal ligament. The needle used is approximately 3 inches in length, No. 20 gauge, and short beveled. It is thrust directly downward until bone is reached. It is easy to feel the needle point as it perforates the capsule, slips into the hip joint, and strikes against the bone of the head or anterior surface of the neck of the femur. A few cubic centimeters of novocain are now injected and then withdrawn up into the barrel of the syringe. If the solution moves freely into and out of the syringe and if it is found to be blood tinged, especially if there is evidence of old blood, one can be sure that the point of the needle is properly placed within the hip joint. About 30 cubic centimeters of 2 per cent novocain solution is injected. This usually completely fills the joint space, and increased pressure within the joint is determined by the fact that when the plunger of the syringe is released it rises up in the barrel. We do not hesitate to use larger amounts of novocain when necessary. Perfect anesthesia for reduction can be obtained by this method.

*Reduction.* Reduction is accomplished by traction in flexion, adduction, and external rotation. The hip is flexed to a right angle with the knee bent and pull is exerted directly upward. An assistant may help by putting his hand under the great trochanter and pushing upward, but usually no difficulty is experienced. Shortening has been corrected by this maneuver. While the assistant continues to give support by pressing upward under the great trochanter, and while the fractured surfaces are facing each other, the limb is turned into internal rotation and carried down into complete extension and abduction. Internal rotation brings the fractured surfaces closely together. Extension and abduction lock the fracture securely so that no further traction is necessary. An assistant sits on a stool, supports the limb, and holds it steadily in this position. It is doubtful that infolding of the capsule between the fragments can occur, and movements of circumduction for the purpose of releasing such engagements are probably unnecessary. Leadbetter's "heel-palm test" is used to help confirm reduction and the manipulation may be repeated if there be uncertainty.

Roentgenograms are now made while the surgeon is preparing for and making the second injection of novocain. The patient lies on a special tunnel for roentgenograms and the films are changed from the opposite side of the table. It is very convenient to have a small dark room set up within the operating room, or a closet adjacent to the operating room can be used. With warm, concentrated solutions, the films can be developed very rapidly and the surgeon loses no time during the operation. The skin and subcutaneous tissue over the outer aspect of the upper end of the femur are injected with ½ per cent or 1 per cent novocain solution. By the time the injection is completed and the patient is draped for operation, the roentgenograms have been developed and are

ready to be viewed. Any necessary adjustment of position can usually be made without disturbing the sterile technique.

*Insertion of nails.* An incision is made to expose the outer aspect of the upper end of the femur. The incision begins opposite the great trochanter and extends down the outer side of the thigh for a distance of from 5 to 6 inches. The bone is exposed for a distance of 2 to 3 inches just beneath the vasternus line by separating the fibers of the vastus externus muscle. To be sure of reduction, the anterior and posterior surfaces of the neck may be palpated with a finger in the wound.

The head of the bone is now secured in position by 3 small stainless steel pins. The pins are entered from the outer side of the femur and are forced upward through the neck and into the head. The pins are small but very strong; they are made of spring stainless steel about the size of an ordinary match (93/1,000 inch in diameter). They are spear pointed and sharp enough to be forced easily through bone when held in a drill or small detachable chuck handle. They should not be too sharp pointed, else the proper sense of resistance cannot be appreciated. They are approximately 5 inches in length, are threaded in their outer three-fourths, and have a small nut which serves two purposes; to regulate the length and to convert the pin into a nail, so that the fragments can be impacted and nailed tightly together. Because the cortex of the bone just beneath the trochanter is relatively soft and thin, the nut on the upper nail is the largest of the three, and of sufficient size to prevent crushing of the cortical shell when the fragments are nailed. Because this nail is not directed upward at such an acute angle as the lower ones, the large nut lies flush against the side of the bone. Where the two lower nails enter the bone the cortex is thick and very hard; only small nuts are necessary. The small nuts we use are beveled so that they, too, lie flush against the bone, even though the nails are directed upward at a very acute angle. The nuts are roughly corrugated, and when driven tightly into the bone it is almost impossible for them to become unscrewed. The threads on the nails also tend to lessen any slipping that might occur with smooth round pins.

The point where the first nail is inserted is located just below the vasternus line, in the middle of the outer aspect of the femur. The second and third nails are introduced about 1½ inches lower on the shaft, and are respectively nearer the ventral and dorsal surfaces of the femur. These 3 points form approximately an equilateral triangle when viewed from the outer side. The apex of the triangle, or top nail, is below the base of the great trochanter and in the vasternus line. The base of the triangle is about 1½ inches lower on the shaft. If one has studied well the anatomy of the upper end of the femur, he will have no difficulty in placing the nails properly. The surgeon should visualize the configuration of the upper end of the femur. He should have in mind the anterior torsion of the neck to approximately 12 degrees and realize that with the foot of the patient internally rotated to this extent, the neck of the femur lies flat and in a perfectly horizontal plane. Therefore, the first nail is directed toward the head of the femur in a line which is parallel to the level, horizontal top of the table on which the patient is lying.

When the second or anterior one of the lower nails is inserted, the 135 degree angle which the neck makes on the shaft, and the fact that the anterior surface of the neck is practically flat and continuous in the same plane with the anterior border of the femur are the main considerations. This nail, therefore, when directed toward the head of the femur, forms with the shaft an angle of approximately 135 degrees. Because of the flat anterior surface, this nail is also directed in a line parallel to the surface of the operating table. The posterior surface of the neck is in approximately the same plane with the middle of the outer aspect of the femur.

To reach the head, the posterior or third nail must be directed forward 25 to 35 degrees, as well as upward 135 degrees. Since all of these angle measurements vary slightly in each individual, no angle measuring device is advocated. The surgeon places the nail at the proper spot for insertion and directs it at approximately the correct angle toward the head. The position of the midpoint of the head is marked by fastening a skin clip just over the point where the femoral artery and the inguinal ligament cross each other. It is toward this point that the nails are aimed. As the nail travels along the soft medullary cavity of the neck toward the head, very little resistance is felt. If hard resistance is encountered, it means that the point of the nail is striking the bony cortex of the neck. In such an instance, the nail is easily withdrawn and redirected. When properly placed, the nails pass easily with the same firm pressure up through the neck and into the head; resistance tells the surgeon when the upper, dense region of the head has been reached.

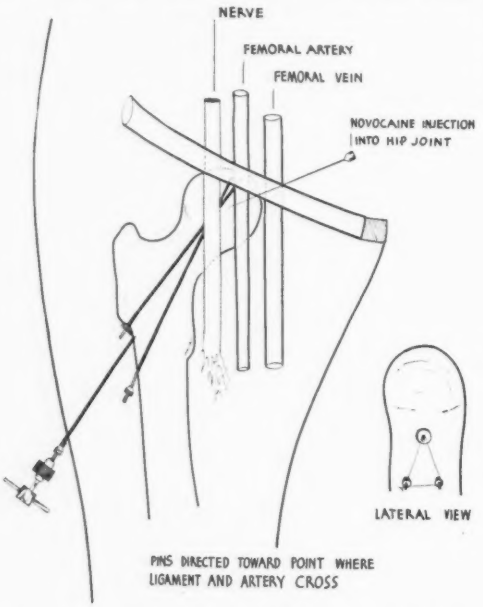
The length of the nail has been previously determined by study of the roentgenograms. The x-ray image is a projected one and is larger than the actual bone itself. We set the length of our

nails approximately ¾ of an inch shorter than the length of the neck as it appears in the roentgenogram. An exact determination of the length of the nail may be made by strapping a small graduated metal rod on the side of the patient's thigh, opposite the great trochanter. Comparison of this image in the roentgenogram with the femoral neck will give the exact length of the nail demanded. This previous determination plus the fact that the dense head can be palpated with the nail point make it very unlikely that the nail will be forced in too far. With reasonable care, there seems to be practically no danger of penetrating the acetabulum with serious damage to important structures. As an additional precaution, we always rotate the hip after each nail is inserted, to be sure that the acetabulum is not engaged. The length of the nail can easily be adjusted by turning the nut on its outer end.

*Check-up and closing steps.* When the surgeon is reasonably sure that the nails are properly placed and that the head is securely in position, anteroposterior and lateral roentgenograms are made with the focal spot of the x-ray tube directly above the hip joint. The lateral views are made without moving either the patient or the x-ray unit. The lower extremity is slightly rotated internally and the hip joint is flexed to a right angle. This position (lithotomy position) gives a perfect lateral view of the femoral neck. While these films are being developed, the surgeon proceeds with certain other details of the operation so that there is no loss of time.

We believe that making several other drill holes up through the neck and into the head leaves channels through which capillary loops can travel upward and that a better blood supply to the head will be established. Bozsan, who introduced this idea, unwinds a regular bone drill and believes that he leaves small bone chips along the passageway. He feels that he has demonstrated that this drilling of the head is definitely helpful. We use only another one of the nails, properly adjusted for length, for drilling these additional holes. We usually place 4 to 6 additional drill holes. If it has been necessary to reinsert any of the nails, we take this into consideration in numbering the additional holes.

A small piece of soft, stainless steel wire (.014 inches orthodontic) is now wrapped behind the nuts from one nail to the other and tied so that the nails are laced securely together. The wire serves a double purpose—the nuts cannot work off the nails, and the nails cannot slip backward out of the bone. Because the nail points converge toward each other, any attempt of any or all of them to work out backward would cause a widening or divergence of their bases. The wire pre-



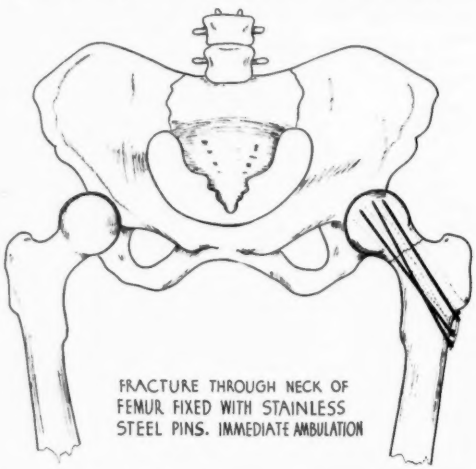




Fig. 1. Left, Represents site for injecting hip joint with novocain and shows the method of inserting pins. Lateral view shows large nut on upper pin, small nuts on lower pins and wire that holds them together. Right, Landmark for inserting upper pin just beneath vasternus line. Pins directed upward at acute angle to take mechanical strain. Extra drill holes to increase blood supply shown on dotted lines. Nails held in place by small wire.

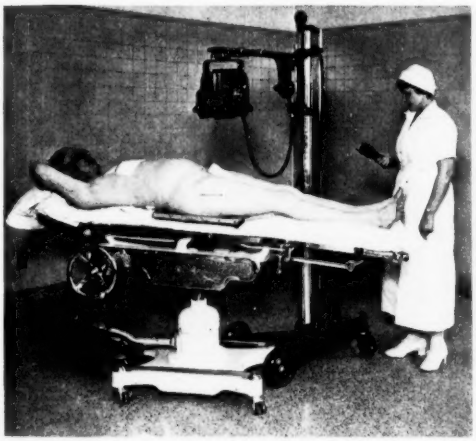


Fig. 2. Photographs showing patient on table, line of incision, mobile x-ray unit and tunnel which enables x-ray technician to change films from the opposite side of the operating table.

vents this; therefore, no backward motion can occur. In addition to this mechanical factor, the vastus externus muscle and fascia are sutured over the nails and wire. A double assurance is given that no backward movement of the nails can take place.

The roentgenograms by this time have been developed and can be viewed. If necessary, minor changes can be made in the position of the nails without removing the small wire which laces them together. The wire can be easily clipped if considerable change is demanded. With practice one can accurately insert the nails so that, as a rule, the position as found in the roentgenograms is satisfactory. The closing steps of the operation are now carried out. A small nail set is placed over the ends of the nails, and a few firm blows with a mallet tightly engage and impact the fractured surfaces. The nails cannot move in any direction, and the fractured head is solidly and firmly fixed in its proper position. The projecting ends of the nails are cut off with a strong wire cutter. About ¼ of an inch of the nail is left protruding so that it can be easily grasped for subsequent removal when necessary. The vastus externus muscle and its fascia are sutured so as to cover the nail ends and the rest of the wound is closed loosely in layers. We use 3, or perhaps 4, interrupted silkworm gut sutures for the skin.

### ADVANTAGES OF THE METHOD

The present technique represents a gradual process of development. The threaded nails with

Fig. 3. Special instruments used in the operation. The nails, nail set, wire, reamer, and chuck are made of stainless steel. The hammer, drill, and nippers are nickel-plated hardware. *1*, Long head hammer; *2*, ratchet drill for drilling holes in hard cortical bone; *3*, adjustable nails (stainless steel); *4*, stainless steel wire, gauge .012; *5*, chuck for holding and directing adjustable nails; *6*, nail set; *7*, nippers for cutting off projecting ends of nails; *8*, reamer to change drill hole to oblique angle.

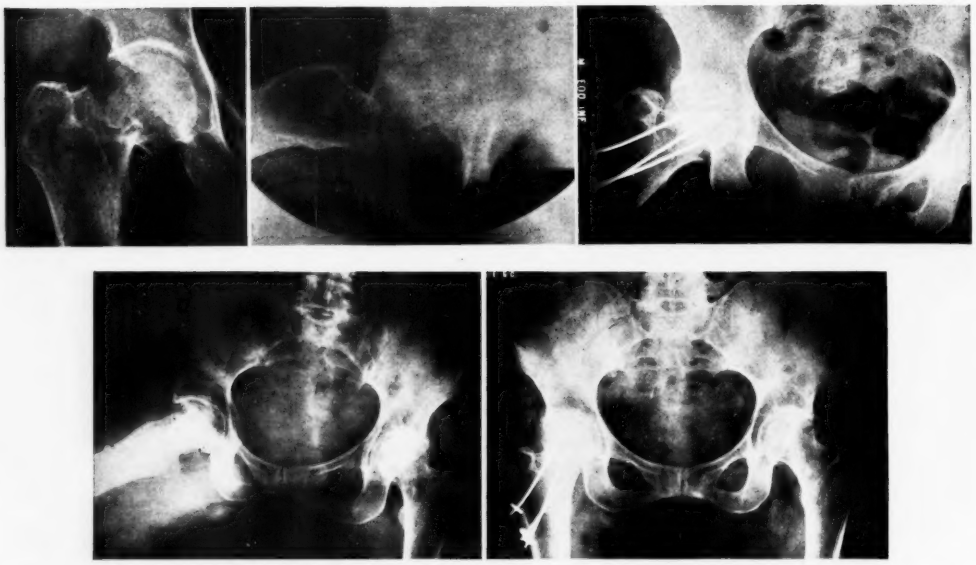


Fig. 4. Mrs. H. D., age 76 years. Complete series of case with end-result. This woman was considered hopeless. She had advanced cardiorenal vascular disease, her general condition was extremely poor, and it was very doubtful that she could stand any type of operative procedure. Local anesthesia was used, she recovered beautifully, and was up in a wheel-chair the next day. She was dismissed from the hospital 1 week after the operation, used crutches for several months, and has made a complete recovery with perfect function, no limitation of motion, and no pain. Her general health seems better now than it was before her accident. Above, anteroposterior and lateral views before operation and check-up view at time of operation. Below, anteroposterior and lateral views which were made 14 months after operation and show solid union and excellent position.

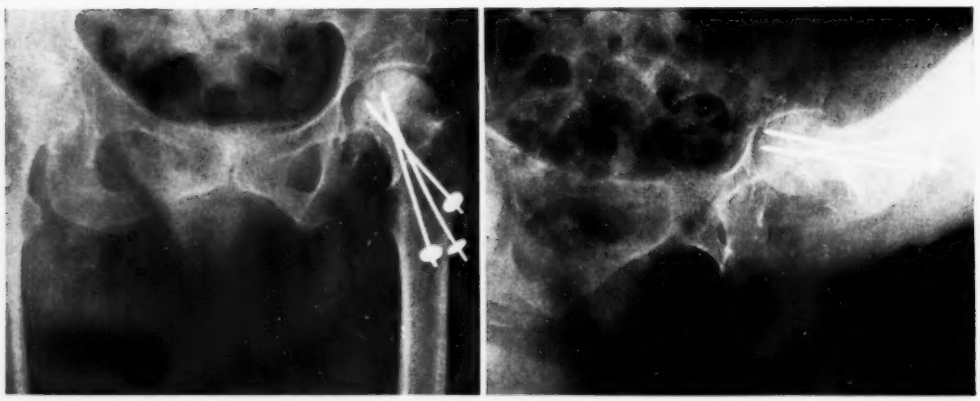


Fig. 5. Patient 88 years of age. In this case a mobile x-ray unit was not available. We were so certain, clinically, that the pins were correctly placed that we completed the operation before the x-ray plates were made. We saved time by omitting the roentgenogram before operation and also saved the patient from moving to and from the x-ray room. The wound could easily have been reopened if necessary.

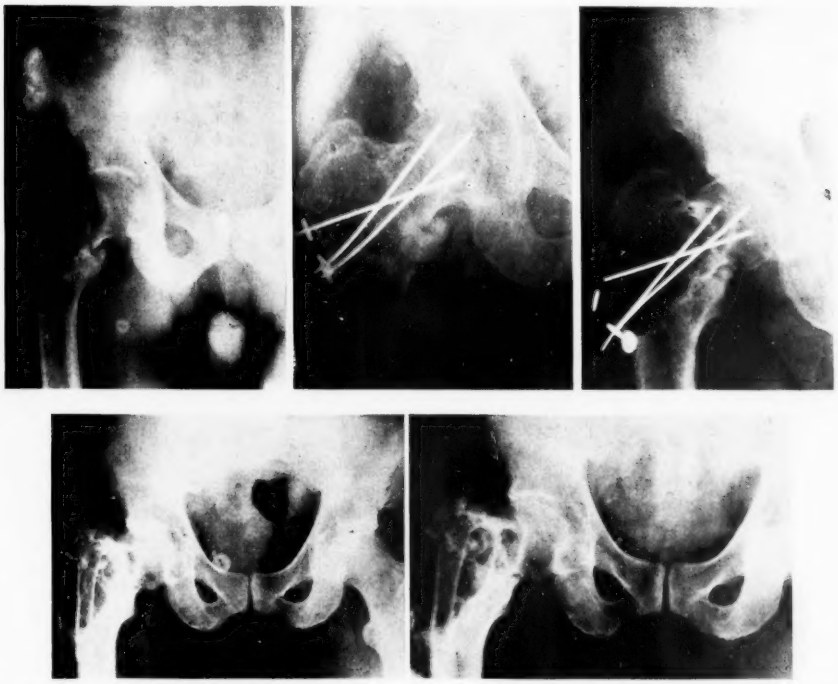


Fig. 6. Case of ununited fracture and giant cell tumor cured by nailing. Above, before operation—non-union 15 months, unable to walk; immediately after nailing operation; and almost 1 year after operation. Tumor increased in size, but union almost solid. Below, 15 months after operation, solid union of fracture, but tumor larger and more painful; and 6 months after operation to remove nails, curette tumor and do bone graft. Union solid, tumor healed, excellent function, no pain. This patient was operated on (nail fixation) November 26, 1934. At that time he had an ununited fracture of the neck of 15 months' duration. Also the original film showed a small cyst in the upper end of the femur. We drilled a number of holes through the fracture site—similarly to curetting the fractured surfaces. He walked after 4 days. The fracture completely healed, but the cyst grew and he began to have pain after about 1 year. In February, 1936, I removed the nails and curetted the entire upper end of the femur. It was a giant cell tumor. He almost bled to death. I used the entire upper part of the fibula to graft the cystic cavity. The old fracture site at the neck remained perfectly solid. After operation we gave an extensive x-ray therapy. I was afraid that x-rays might retard osteogenesis, but it did not. New bone rapidly formed, the graft healed, the fracture is well and apparently the tumor area has been cured. Patient clinically is entirely well, walks without support, has normal motion and no pain. This last picture was made in September, 1936.

nuts were developed after numerous trials with other materials. Kirschner wire, smaller pins, or pins made from softer material will bend at the site of the fracture. Larger pins, pegs, or nails cause unnecessary traumatism. Pins without nuts were found to work forward, and, without the small wire which we now use to tie the nails together, we found that the nuts could work loose and that one or more of the nails could move backward.

Local anesthesia is the safest of all anesthesias, and usually no shock follows the operation. It can be used on practically any patient. Local anesthesia has been used in most of our cases. We have used spinal or general anesthesia when circumstances made it more suitable. The matter of anesthesia is an individual preference, and local is not exclusively recommended.

As a rule x-ray expense is minimal. A surgeon with experience can perform this operation without x-ray guidance. I have had to do this several times. The check-up roentgenograms almost invariably show that the nails have been perfectly placed. Any change in position of the nails is very easily made.

Equipment for the operation is very simple and inexpensive. The tripod form of fixation is sound mechanically, rotation is impossible, and the frag-

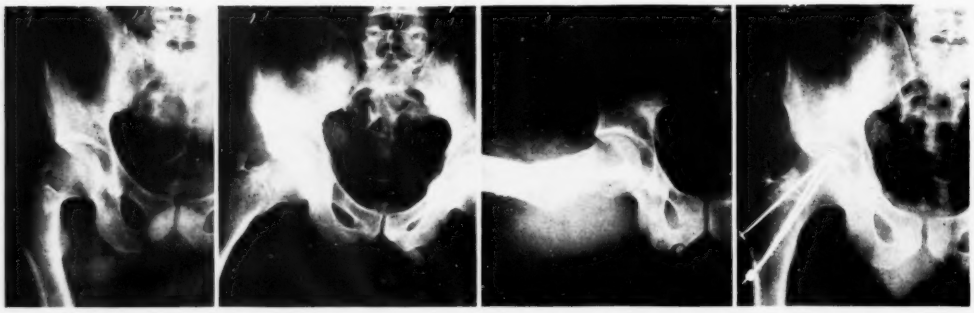


Fig. 7. R. P. W., age 42. These photographs are of a recent case, but are included to illustrate the new type of nails which we now use, and to show that the operation can be done accurately without x-ray guidance. This case was done in an institution where portable x-ray machine was not available. We anesthetized the patient and took a film immediately after reduction. While this film was being developed we rolled the patient to the operating room and did the operation entirely by the sense of feeling. The wound was closed and the patient rolled back to the x-ray room where films were made of the result as shown. Note how tightly impacted the fracture is after it has been nailed together. Compare second and fourth plates. This case was treated about 10 weeks ago. The patient is up now on crutches and doing fine. We used spinal anesthesia. We have treated a number of cases in this way, without x-ray check-up during operation. The result is almost always satisfying.

ments are fastened together almost as solidly as before the fracture occurred. The fixation material is small and causes a minimum amount of trauma. It is impossible for the nails to work out backward. It has been argued that unless the nails are parallel, they hold the fragments apart if absorption of the neck takes place. This does not hold true clinically. We have seen the head slide down on these nails and unite, even when there is extreme crossing. A comparison may be made to a rod cutting its way through a block of ice, or to an orthodonist moving a tooth. There is absorption in front where pressure is made, and filling in behind. By this means, the fragments in a femoral neck fracture are allowed to come together, even though there is crossing of the nails. We are always careful to have the fracture perfectly reduced, or in a slight valgus position. We are also careful to start the nails from low on the shaft and direct them upward at an acute angle toward the head. The head is supported more nearly in the vertical position, and the nails mechanically and physiologically are able to carry the greatest stress and strain. By engaging the upper dense cortical portion of the head and the lower hard, cortical bone on the side of the shaft, it is possible to nail together tightly 2 hard surfaces. The fragments are jammed together with muscular activity or with weight bearing, and union is stimulated. If the nails are driven in from the side of the trochanter at more or less right angles to the shaft, the head is not properly supported in a mechanical way; a shearing force is applied on weight bearing, the fracture line gaps open, and non-union will result. If the nails are not driven far enough up into the head to reach the upper dense cortical region, the medullary cavity is too soft and spongy to carry the strain, and position of the fragments will be lost. The points of the nails should engage the head in widely divergent locations; otherwise, if only a small portion of the head is engaged, it might break off with the strain and the operation would end in failure.

The operation does not take a long time. With experience it can easily be done in 30 to 40 minutes. It is safer than the intra-articular type of operation, in which the fragments are replaced under visual control. Less disturbance to the blood supply, less shock to the patient, and less risk of infection follow. Blood supply is actually increased by drilling of the neck.

Last, but not least, practically all fractures of the upper end of the femur can be treated by this method. Multiple nails can be used to nail comminuted intertrochanteric fractures together; or two nuts can be used on a nail to convert it into a bolt when necessary.

### OBJECTIONS TO MULTIPLE NAILING AS COMPARED TO SINGLE THREE FLANGED NAIL

The operation must be done very carefully. Perfection comes only with experience and a thorough knowledge of all the mechanical, physiological, and technical factors involved. It is not an operation for a novice, but it is simple when well understood. This is true of both methods. Multiple nailing probably requires a

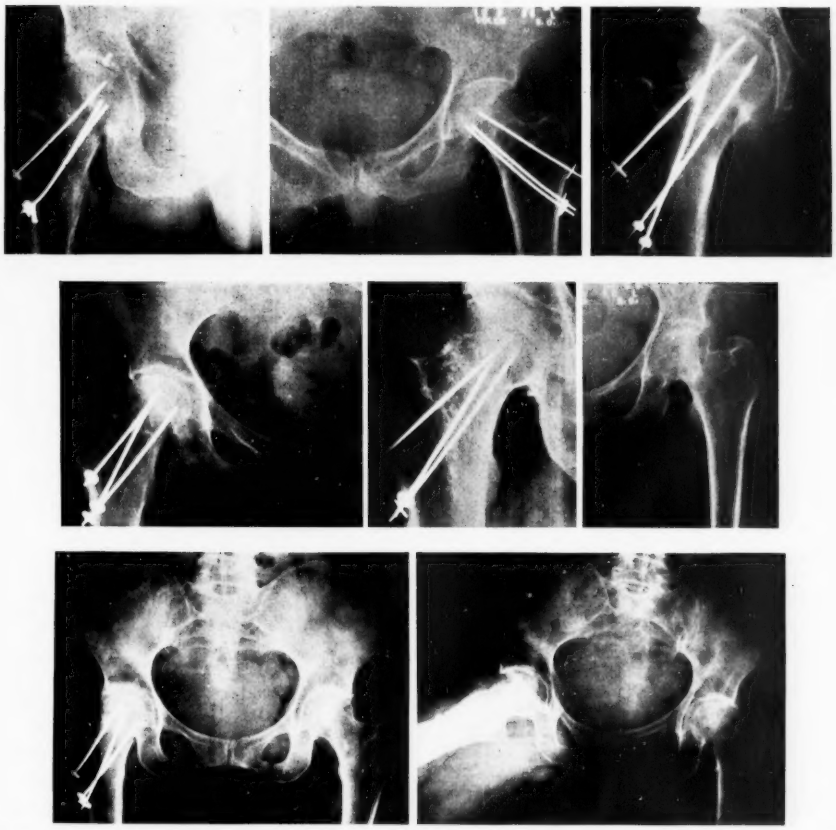


Fig. 8. These roentgenograms are end-result studies of a number of different cases. The good valgus position of the head is shown and the nails are directed upward at an acute angle from points low on the shaft of the femur. In 1 case the nails have been removed. The two lower photographs are anteroposterior and lateral views of the same patient. Even though there is extreme crossing of the nails, solid union has occurred. This case refutes the argument that crossing of the nails will not allow the fragments to come together if there has been any absorption of the neck of the femur.

little longer time on an average, but on one occasion we completed the operation in 16 minutes. It takes a little longer, perhaps, to place three nails than it does one, but the ease with which they are withdrawn and re-inserted, and the possibility of placing them very accurately should overbalance this objection. As a rule, one is positive that they have been properly placed, and the operation is completed while roentgenograms are being developed.

A slightly larger incision and slightly more dissection to expose the outer side of the femoral shaft are necessary, although these factors seem negligible.

If absorption of the neck takes place, it is relatively easy for the nail points to penetrate the head and project into the joint space. Manipulation of the limb after each nail is inserted should prevent the possibility of any nail being driven in too far at the time of the operation. If the nail points do go in too far, the chances of a traumatic arthritis would seem very likely. We have not met with this complication and only in one instance have we had to withdraw a nail partially. This patient had considerable absorption of the neck, some pain, and restricted joint motion. The one nail was partly withdrawn. He has no pain, union is solid, and all the nails are still in place.

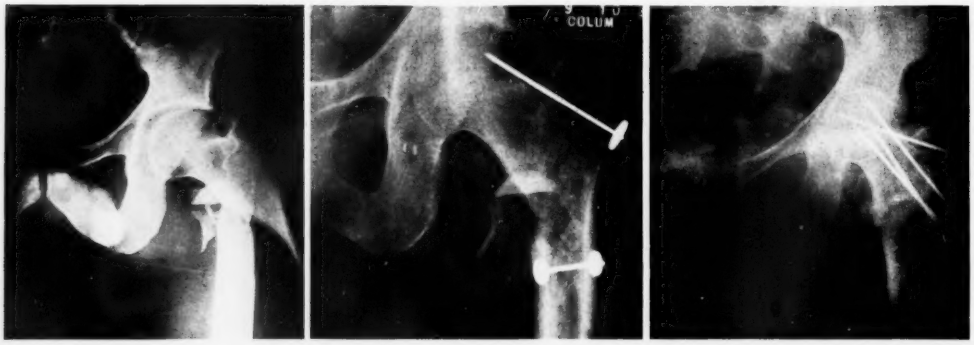



Fig. 9. These 2 cases illustrate one of the advantages of multiple nailing over a single three flanged nail. In neither of these cases could it have been possible to maintain accurate fixation by the use of a single three flanged nail. Left 2 plates Mr. C. D. S., white, age 35. This case, without question, could not have been treated with a Smith-Petersen nail. I put two nuts on one of the pins and used it as a bolt. Another nail was used to hold the trochanter back together. The second photograph shows the patient 2 months after the operation. Union is solid, position is perfect, and an excellent result was obtained. This man never wore a cast, or any other external type of splint. This case has *not* been included in our report of 64 operations. Right plate, Mrs. M. G., white, age 80 years. This photograph represents a case in which four nails were necessary for maintaining correct position. The fracture was a severely comminuted intertrochanteric one. The reduction is excellent, and position was maintained by nails. No cast, or external appliance was used, and an excellent result was obtained.

It has been argued that crossing of the nails holds fragments separated. Our clinical experience indicates that this assumption is not correct.

### POSSIBLE OBJECTIONS TO THE THREE FLANGED NAIL

The operation may be long and many roentgenograms necessary. The nail is larger, causes more traumatism, and does not fix the fracture as well mechanically as do the properly placed three nails; a full stock of various sizes is necessary because the length of the nails cannot be changed; the selection of the proper length nail is not easy; the nails cannot be readily withdrawn and reinserted and special apparatus for their use is required. In treating intertrochanteric fractures the bone may be split when the nail is used. Where one has a perfectly reduced fracture and everything is progressing beautifully, it is a catastrophe to check up with roentgenograms after a few weeks and find that misplacement has occurred due to imperfect fixation. This accident has been reported frequently with the flanged nail, as there is nothing to prevent it from working out backward.

### POSTOPERATIVE CARE

Immediately after operation the patient is shown that free movement of the hip joint is possible. She is then instructed to move the joint actively herself. With the anesthetic effect of the novocain still present, she finds that she can move the extremity freely without pain. If her general condition permits it, she may be allowed to sit up on the side of the operating table and move her lower limbs. These movements convince her that her hip is solid, give her encouragement, and greatly increase her morale. She is then put back to bed for the remainder of the day, or until she has completely recovered from the operation. She is propped up in bed as soon as possible, usually the day after the operation. We try to get these patients up and about just as soon as their strength and general condition will permit. It is remarkable to see how they improve as soon as their pain is relieved by reduction and fixation. In a few days they may be up in a wheel chair, or may be allowed to use crutches. Further hospitalization is not necessary, and patients who want to leave the hospital for financial or other reasons may be dismissed.

We have felt that a brief period of immobilization in plaster, or other apparatus, immediately after operation can do nothing but harm. Some men have advocated a support for 3 weeks following similar operations. Certainly no callus to aid in fixation can form in so short a time. Absorption of bone, agglutination of soft tissue, joint stiffness, and muscular weakness can progress very rapidly in a plaster splint. If reduction is perfect, and the nails have been properly placed, no external support is necessary. Occasionally a light plaster boot with horizontal board is helpful for preventing external rotation. A small board

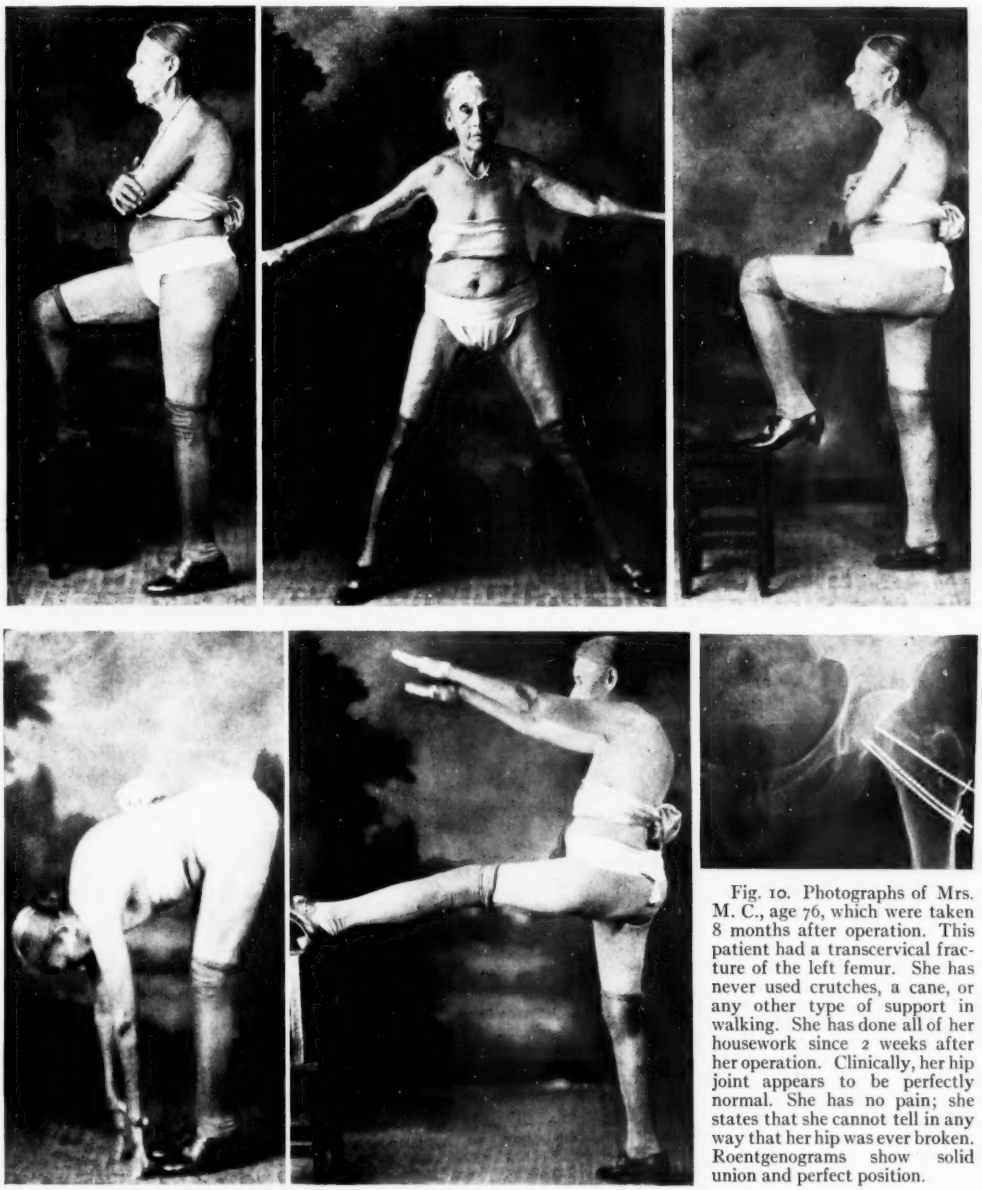


Fig. 10. Photographs of Mrs. M. C., age 76, which were taken 8 months after operation. This patient had a transcervical fracture of the left femur. She has never used crutches, a cane, or any other type of support in walking. She has done all of her housework since 2 weeks after her operation. Clinically, her hip joint appears to be perfectly normal. She has no pain; she states that she cannot tell in any way that her hip was ever broken. Roentgenograms show solid union and perfect position.

nailed to the heel of a bedroom slipper may suffice. We have put these nails in femurs which were artificially fractured; the head could not be pulled off without great force and a weight of over 150 pounds can easily be carried on the femoral neck. Frequently patients insist that they can walk without crutches, but we caution them that weight must not be borne for fully 6 months.

Fig. 11. This patient, 93 years of age, suffered a complete intracapsular fracture of the right femur. Photographs were made 5 weeks after operation at which time she was able to be up and about and was getting along well. Unfortunately, about a week later she developed a bad cold, had to go to bed, contracted pneumonia and died.

Patients with fractures through the base of the neck or with intertrochanteric fracture may begin weight bearing sooner. We are not afraid of the efficacy of the mechanical fixation, but we have felt that following fracture there is apt to be weakness of the detached head due to lack of blood supply or from aseptic necrosis, and that with the trauma of weight bearing there might be a crushing of the head or of the articular cartilage with resultant deformity, or traumatic arthritis. We are wondering now if this observation is entirely correct. Perhaps weight bearing might be helpful. We have observed a few cases in which our advice was not followed and in which full weight bearing was begun early. We have not had time enough or a sufficient number of cases to be convinced of this possibility, but apparently no harm has been done. If the head is devoid of blood supply, there are no channels through which absorption can occur, and it remains as a hard, dense substance, sufficient to bear the strain which is placed upon it. It is understood that cartilage does not withstand avascularity as well as bone and that liquefaction of the capital cartilage might occur with subsequent atrophic arthritic changes in the joint. However, the end bearing thrust of moderate weight bearing may be productive of rapid union with revascularization of the head; this factor may be a very important element in preventing atrophic changes from taking place.

### POSSIBLE COMPLICATIONS

*Operative mortality.* Thus far we have not had a single case in which we felt that death could be attributed directly to the operation. We have not selected our cases and have operated on every patient we have seen, with only one exception. That patient refused operation. He was 80 years of age and, like many of our other cases, was an extremely poor risk. He died 2 weeks later. Our mortality rate under such circumstances has necessarily been high, but the operation itself does not seem to have an unfavorable influence on the prognosis. Our oldest patient, a very feeble old woman 93 years of age, stood the operation beautifully. She was able to be up and about and was getting along well, when 6 weeks after the operation she contracted a cold, went to bed, developed pneumonia, and died. We feel satisfied that by the operation we have saved some lives, and that in certain other cases we have allowed the patients to end their days in relative comfort. We feel that it is merciful to try to relieve these old people even though their days are numbered under any circumstances.

*Infection.* With sufficient volume of surgery a small amount of wound infection is unfortunately inevitable. Fortunately, we have not yet had any seriously infected wounds. In case severe infection should occur, opening the wound and removing the nails should keep it under control. The operation is an extra-articular one, therefore the danger of joint infection should be relatively small. In 2 of our cases a slight discharge was present for a few days, but the drainage was of a very trivial nature. One patient had a serous discharge which persisted for several months. We probed the wound and found a small gauze sponge. This was withdrawn and healing immediately occurred.

*Intercurrent affections.* Most of our patients have been old and have had the usual affections incident to old age and enfeeblement. There has developed no condition which we felt had any direct relationship to the fracture or to the operation.

*Aseptic necrosis.* As yet, this condition has not presented itself in our series of cases, although we have studied the roentgenograms carefully in each case. It may have been present, however, in a form which we were unable to detect.

*Traumatic arthritis.* The presumption has been advanced by some that nailing and impacting the fragments would damage the articular cartilage

and produce arthritis. Our cases are impacted very lightly. The blows of the mallet are just sufficient to force the fragments tightly together, and not enough to produce crushing at the fracture line. The normal individual subjects his hip joint to tremendous violence by the jarring force of walking, running, jumping, or similar activities, without the development of traumatic arthritis. The force of light impaction is not as great as these strenuous exertions, and in our series we have not observed that damage has been done. One of our patients developed apparently an ossification of the entire joint capsule, with partial ankylosis. We felt that it was an irritative reaction to the novocain injection or that possibly some chemical contamination was present. The patient is an inmate of the insane hospital and apparently suffers no inconvenience or pain.

*Restricted joint motion.* Following prolonged immobilization in abduction spica splints, limited joint motion is always expected. After removal of the splint, there is a tendency for the hip to be drawn in flexion and adduction. Special exercises are necessary to try to restore the power of abduction, even though the limb has been fixed in this position for a long time. It has been argued that there would be the same tendency toward adduction and flexion deformity following nailing of a hip joint fracture. This is not true. Following accurate fixation, muscle spasm is relieved, there is a full range of active motion, and there is no joint stiffness anywhere.

*Loss of position by inadequate internal fixation.* It is true that nails will move forward or backward in bone unless they are restrained. Loose nuts will work off their nails, or nails will turn and move forward or backward and leave the nuts *in situ.* We have had these experiences in the past. The nails are now made with very tight fitting nuts and the nuts themselves are wedged into the bone at operation. The addition of the small wire which laces the nails together, now makes it almost impossible for these complications to occur. We have had no loss of position of any kind since adopting the method as outlined. If the operation be done properly, we believe that there will be absolute and permanent fixation.

## FUNDAMENTAL PRINCIPLES IN FRACTURE TREATMENT

The following are well recognized, fundamental principles for the treatment of fractures in general and are pertinent to the subject under discussion.

One of the best means of stimulating callus formation is to bring about good circulation by active movements of the broken limb after the fragments have been accurately reduced and perfectly immobilized.

In cases of delayed union, long continued, undisturbed fixation of properly reduced fragments, accompanied by free and active use of the injured limb, will bring about satisfactory union and good results (e.g., the ambulatory treatment of tibial fractures).

Any shearing movement that takes place at the site of a fracture will prevent callus formation and will predispose non-union.

Repeated inspections of a well set fracture and manipulations to determine whether or not union has taken place are very harmful. The properly reduced fracture should be left alone until roentgenograms reveal solid, bony union. A "wiggle a week" by the curious surgeon may cause sufficient damage to produce delayed union or even non-union.

A certain amount of absorption usually takes place at the site of any fracture. However, when movements of the fragments are allowed, hyperemic decalcification is increased, absorption of bone is intensified, and delayed union results. If, on the other hand, the fragments are perfectly reduced and perfectly immobilized, a minimum amount of absorption will take place and there will be rapid revascularization and prompt union. New bone will not jump a gap to form union. The fragments must be pressed tightly together and preferably impacted lightly. If absorption occurs at the site of a fracture, the fragments must be allowed to jam tightly together with muscle spasm and with use; otherwise, non-union will result.

Distraction of fragments will produce delayed union or non-union. If a plate is applied and space is left between the ends of the bones, non-union will result. Skeletal fixation by means of a pin above and below the site of the fracture, the bone being transfixed and incorporated in plaster, may result in non-union due to the fact that the bones are held apart at the site of fracture. When both bones of the forearm or leg are broken, one of the bones may unite and leave a space between the fragments of the other bone; in this case non-union will develop. This condition can be cured by simple osteotomy of the united bone, so that the other fragments can be closely approximated. Drilling of the fragments increases blood supply and promotes union.

Even in a case in which non-union has existed for a long time, it is possible to obtain successful union by perfect immobilization of the fracture and by allowing at the same time active movements of the injured member and by applying

intermittent pressure in the long axis of the bone. Examples of this principle are cases of ununited fracture of the carpal navicular bone cured by long continued plaster splints with active use of the hand; and cases of non-union of the neck of the femur cured by subtrochanteric osteotomy with subsequent weight bearing. We have cured a case of non-union of the femoral neck of 15 months' duration. The fragments were immobilized by nail fixation and subsequent weight bearing was encouraged.

When a broken bone is held in proper position and alinement and at the same time intermittent pressure of weight bearing is allowed through the long axis of the bone, an increase in callus formation and a more rapid union of the fracture will result.

These principles may be applied to fresh fractures of the neck of the femur.

If excellent results can be obtained by treating fresh transverse fractures of the tibia with walking stirrups and weight bearing, why not allow a certain amount of weight bearing following nail fixation of fractures of the femoral neck? One of the claims of this method of fixation is that the fractured surfaces are held in perfect apposition, but at the same time they are allowed to jam tighter and tighter together if any absorption does take place. One of our patients with incomplete fixation did have marked absorption of the neck, but the head slid down on the nails and union has taken place in good position. We have advised against full weight bearing because, in many of the cases, the bone is soft and porous, with a very thin cortical shell. It would be disastrous if crushing occurred with displacement of fragments. We instruct the patient to allow the foot on the injured side to rest on the ground when crutches are used. This slight pressure and the normal muscle pull when the hip is activated seem sufficient to keep the fractured surfaces wedged tightly together. Possibly in young subjects, in whom the bone is hard, if the fracture is through the base of the neck or intertrochanteric region, and if it can be held perfectly with nails, early weight bearing might be justified. We always tell the patient that crutches must be used for at least 6 months. Check-up roentgenograms can be made at the office from time to time. The roentgenographic appearance of union is frequently misleading in these fractures and we feel that one should err on the side of safety rather than remove the nails too soon.

Unless evidences of irritation are present, we feel that the nails should never be removed in less than 1 year. If there is any doubt whatever about union at the end of that time, the nails should be left in place as long as is necessary. In some cases they may remain indefinitely. When removal is decided upon, it may be done easily under local anesthesia. The small wire is clipped and the nails may be withdrawn easily. The stainless steel material which we use seems to be absolutely non-irritative. This has been proven by laboratory tests (incubation in Ringer's solution at high temperatures causes no corrosion of the nails). We have not observed a single case in which there was absorption of bone about the nails.

### STATISTICAL STUDY AND CONCLUSIONS

A total of 64 patients have been operated on in the past 2½ years. All patients with intertrochanteric fractures have obtained solid, bony union. Forty-two of these 64 patients had recent fractures of the neck of the femur and were treated in accordance with the method described. Because femoral neck fractures are the most discouraging of all fractures about the hip joint, a statistical report of the 42 cases is made.

We have had only 1 case of non-union. This patient was one of our earliest cases and mechanically the operation was not perfectly performed. She is the inmate of an insane hospital and has been very unco-operative in carrying out her post-operative care. Even with non-union she gets about well, and seems to be fairly comfortable. In no case has any patient been left an invalid as a result of the operation. There have been no operative deaths and no wound infections. Twenty-four patients have lived sufficiently long for end-result study and all have union with good function. Our cases have not been selected and we have operated on practically every patient we have seen, regardless of age or general condition. The accompanying table shows that the majority of our patients have been over 60 years of age. Nine of the very old patients died while under treatment. Some of them lived long enough for end-result study, but could not be brought back for roentgenographic examination. Clinically, these results were good and it is believed that solid, bony union had occurred. These 9 patients averaged approximately 80 years of age. Excluding 2 mental cases, the average age of patients who died was over 85 at the time of operation. Without exception, all these patients were benefited by operation and were enabled to live the remainder of their lives in relative comfort.

Eight of our patients have been operated upon in recent months; thus a sufficient length of time has not yet elapsed to make a definite end-result classification. However, with the improvement in

TABLE I.—STATISTICAL STUDY

OPERATIONS—March, 1934, to September, 1936

| | Cases |
|---|---|
| Intracapsular | 42 |
| Intertrochanteric, comminuted, ununited, etc. | 22 |
| Totel operations performed | 64 |

Intracapsular Fractures

| | |
|---|---|
| Subcapital | 18 |
| Central cervical | 17 |
| Impacted central cervical | 1 |
| Base of neck | 6 |
| Total | 42 |

Results of Intracapsular Fractures

| | |
|---|---|
| United | 24 |
| Operative deaths | 0 |
| Died during treatment | 9 |
| Non-union | 1 |
| Operative infections | 0 |
| Recent cases (results undetermined) | 8 |
| Total | 42 |

Age of Patients Who Died During Treatment

| | Years |
|---|---|
| Total deaths | 9 |
| Average age of patients who died | 79.6 |
| *Excluding mental cases, average age of patients who died | 85.4 |

*These feeble patients had very little time left to live. One mental case died of voluntary starvation.

Age Range of 42 Intracapsular Fractures
19 to 93 Years

| | Cases |
|---|---|
| Below 40 | 5 |
| 40 to 50 | 5 |
| 50 to 60 | 7 |
| 60 to 70 | 8 |
| 70 to 80 | 6 |
| 80 to 85 | 3 |
| 85 to 93 | 8 |
| Total | 42 |

Summary

| | |
|---|---|
| Below 60 years of age | 17 |
| Above 60 years of age | 25 |
| Total | 42 |

Living Cases with Definite End-Result

| | |
|---|---|
| Number of cases | 24 |
| Non-union | 1 |
| With union | 96 per cent |

operative ability that experience has given, it is believed that these more recent cases have a better chance for a favorable outcome than the previous ones. All patients are apparently doing well and those who have had recent roentgenograph examinations are progressing nicely; in no case has there been a loss of position.

Twenty-five cases of fracture of the neck of the femur have been operated upon a sufficient length of time for a definite end-result study to be made. There has been failure of union in only 1 of these cases. In other words, 96 per cent of our patients have gone on to a successful end-result. This seems to us to be a fair figure. The more recent cases have been better handled and it may be that later results will be better; on the other hand, time may prove that the results are not so good as we now appraise them. However, if 96 per cent of union can be achieved in a regular run of patients, the development of any procedure of internal fixation will have been worth while.

This method has been in use for only the past 2½ years, and it is not believed that a sufficiently convincing compilation of statistics can be accumulated in that length of time to be of positive value. It may take years of observation to determine the end-result in these cases. We are trying to keep all cases under observation and we instruct each patient to return for roentgenographic examination every 2 months for at least a period of 2 years. Many of the patients live at a distance and will not return regularly; many of the older ones cannot live 2 years after their accident; the compilation of statistics is therefore difficult.

Our results to date have been encouraging. We feel that this method is a decided improvement over the manner in which we formerly treated similar cases. We have had no catastrophe and no cause to regret using it in a single instance. Our experience has led us to believe that internal fixation of fractures of the hip joint is the method of choice. It is our opinion that if the fracture is carefully and perfectly reduced, if reduction is perfectly maintained over a long period of time, and if freedom of activity is allowed, a favorable result will be achieved in practically every instance.

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# THE FRACTURE WORK OF THE ASSOCIATION OF AMERICAN RAILROADS

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THE Association of American Railroads has a surgical section which meets annually for the consideration of its own problems. This section has approximately 100 members who are the chief surgeons of the member roads. There are several major problems which require the continuous attention of the surgical section and committees are appointed each year to consider these problems and make annual reports. These reports are presented and discussed at the annual meetings and the transactions are published in book form.

The surgical problems which come before this section are primarily those which result from injuries to employees and surgical conditions which may be claimed to be associated with trauma. The relative importance of the various surgical problems can be computed because the costs of personal injuries on railroads are required to be reported annually to the Interstate Commerce Commission. The economic loss which results from each injury is computed. Fractures produce about 20 per cent of the costs.

The fracture work on railroads does not differ materially from the other fracture problems of the communities which the railroads serve. During the past few years the American College of Surgeons and various other surgical organizations throughout the world have come to recognize that the care of fractures is a problem which needs more study and attention, and as a result, committees on fractures have been appointed. Similarly the surgical section of the Association of American Railroads has had a committee on fractures for several years. This committee has consisted of a chairman and four or five other members who are chief surgeons of railroads in the different sections of the United States. The reports of the fracture committee are presented and discussed at the annual meetings. The writer has been chairman of this committee during the past 2 years.

The surgical department of each railroad works continuously to solve and to improve its fracture problem. Some of the roads are well satisfied with their fracture treatment; others feel that there is great need for improvement. The efforts of the fracture committee have thus far been directed towards selecting the best administrative methods used by the different roads and reporting these methods to the section so that they may be tried out and, if found practical, adopted on the other roads.

In one questionnaire which was sent to all railroad chief surgeons the latter were asked if they considered recent medical school graduates competent to handle fractures on their roads. The answer was almost uniformly, "No." When in the next question they were asked if they thought a one-year interneship was sufficient qualification, the answer was the same.

It is of interest to note that the railroad surgeons are not all recent graduates, but some of them are, and furthermore, they must get their education in fractures after their first year of interneship. As fracture education is often obtained in later life, it is probably the most expensive part of the medical education. The railroads often have to furnish this education. About one doctor in eight becomes a railroad surgeon. In Minnesota they number over 400 and include doctors of all stages, from recent graduates to our leading surgeons.

The fracture committee of the surgical section of the Association of American Railroads has proposed a definite program for the handling of the fracture problem, consisting of four parts. This program is in effect on many of the roads.

First aid and transportation splints as approved by the Fracture Committee of the College of Surgeons have been recommended to all railroads. Some roads have placed these splints with all local surgeons. Ambulance companies have been persuaded to carry the splints and attendants have been trained to apply them. The Chicago ordinance concerning fracture equipment for ambulances has been recommended by the committee, and this ordinance has been adopted by some other cities through the efforts of local railroad surgeons. Many railroads have placed these splints at strategic points for use by the employees when needed.

X-ray diagnostic instructions have been arranged by the railroads and furnished to the local railroad surgeons. These instructions are now generally available in the "Outline" published

Chief Surgeon, Great Northern Railway.

Presented in the Fracture Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19-23, 1936.

# GREAT NORTHERN RAILWAY COMPANY

## SURGEON'S FRACTURE REPORT

1. Name of Injured_____ Place of Accident_____
2. On (Date)_____ 19____. Time_____ A. M. P. M.
   Address_____
3. Occupation?_____ Age?_____
4. Cause of Fracture_____

### FIRST AID AND TRANSPORTATION

5. Was he splinted where he was lying?_____ If the arm or forearm bones were fractured, was a hinged ring (Thomas-Murray) traction splint applied?_____ If the thigh or leg bones were fractured, was a hinged half ring traction splint (Keller-Blake) applied?_____ If the fracture was in a thoracic or lumbar vertebra, was he carried face downward when moved?_____ If other first aid splints were used, please describe_____
6. Hospital entered (Name)_____
   Date_____ Time_____ A. M. P. M.

### EXAMINATION AND DIAGNOSIS

7. Was the x-ray examination made according to the minimum requirements and general directions issued by the company?_____ What part of the skeleton was x-rayed?_____
   Was a view made anteroposteriorly?_____ Obliquely?_____ Laterally?_____ Stereoscopically?_____ Was a Potter-Bucky diaphragm used?_____ What size films were used?_____
8. What bones were fractured?_____
9. Was the fracture simple?_____ Compound?_____
10. Locate and describe the x-ray findings in each fractured bone beginning with the most important fracture and using, as indicated, the following terms: greenstick, subperiosteal, impacted, transverse, oblique, spiral, comminuted (with description), into joint (with description), shortening, over-riding, angulation, etc._____
11. NATURE AND EXTENT OF INJURY TO SOFT PARTS, especially vessels and nerves_____

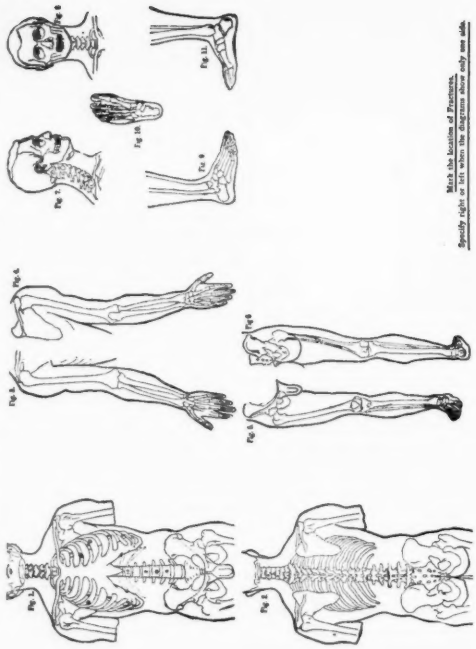
### TREATMENT

12. CLOSED REDUCTION: yes_____ no_____ (a) Number of **hours** after injury_____
    (b) Method and position of fixation_____
    (c) Was an anaesthetic used?_____ General_____ Local_____
13. X-ray after reduction. Describe the result obtained_____
14. OPEN REDUCTION: Yes_____ No_____ Number of **days** after injury_____
15. Method and position of fixation_____
16. X-RAY after reduction. Describe the result obtained_____
17. Period of complete immobilization (estimate)_____
18. Period of protection (estimate)_____
19. Total period of protective treatment (estimate)_____
20. REMARKS:_____

Signed_____ M. D.

Date_____ 193__

*Please mail this report to the Office of Chief Surgeon promptly by first class mail. Please send before and after reduction x-rays by parcel post.*



Mark the location of Fractures.
Specify right or left when the diagrams show only one side.

### GENERAL DIRECTIONS FOR GUIDANCE OF X-RAY WORK IN FRACTURES

Hand. Two views: Anteroposterior and lateral on one 10 x 12 film or two 8 x 10 films; to include fingers and carpal bones.

Wrist. Three views: Anteroposterior, oblique and lateral views on one 10 x 12 or three 8 x 10 films; to include metacarpals and lower third of forearm.

Elbow. Two views: Anteroposterior and lateral on two 8 x 10 films. In case full extension of the arm cannot be obtained, for the anteroposterior view, make two anteroposterior exposures, one with the posterior surface of the arm resting on the plate and one with the extensor surface of the forearm resting on the plate.

Humerus. Two views: Anteroposterior and lateral on two 10 x 12 films.

Shoulder Girdle. Two views: Stereoscopic exposure on two 10 x 12 films, to include head, neck, and upper third of humerus and outer two-thirds of clavicle; forearm and hands in supination. USE POTTER-BUCKY DIAPHRAGM

Chest for Ribs. Two views: Stereoscopic plates in posteroanterior position on 14 x 17 plates.

Skull. Five views: Stereoscopic of both sides of the skull on 10 x 12 films. Single views on 10 x 12 films of the frontal bones, of the occipital bone and a single view of the facial bones made in nose-chin (Water's) position. Total of seven 10 x 12 films. ALL VIEWS ON THE POTTER-BUCKY DIAPHRAGM.

Facial Bones. Two views on three 10 x 12 films. Stereoscopic posterior anterior views made in nose-chin or Water's position. Single lateral view with the affected side down. USE POTTER-BUCKY DIAPHRAGM.

Lower Jaw. One stereoscopic view of the affected jaw upon 8 x 10 films, the ray being directed obliquely upward.

Cervical Spine. Three views. Stereoscopic anteroposterior on 10 x 12 film of whole cervical spine and stereoscopic anteroposterior on 8 x 10 film through open mouth to show atlas and axis. USE POTTER-BUCKY DIAPHRAGM. A single lateral on 10 x 12 film to be made WITHOUT Bucky diaphragm at six foot distance, patient preferably in erect position, with plate against the shoulder and parallel to the spine.

Dorsal Spine. Two views: Anteroposterior and lateral on two 14 x 17 films. USE POTTER-BUCKY DIAPHRAGM.

Lumbar Spine and Sacro-iliac Joints. Two views: Stereoscopic anteroposterior and single lateral on three 14 x 17 films. USE POTTER-BUCKY DIAPHRAGM.

Pelvis including both hips. One view: Stereoscopic on two 14 x 17 films. To cover pelvis, hips, and upper portion of shaft of femur. USE POTTER-BUCKY DIAPHRAGM.

Femur. Two views: Anteroposterior and lateral on two 14 x 17 films. Preferably on Potter-Bucky diaphragm.

Knee. Two views: Anteroposterior and lateral on two 10 x 12 films.

Leg. Two views: Anteroposterior and lateral of portion of tibia and fibula injured, on 10 x 12 films. **All** fractures of the shaft of the tibia with over-riding of fragments without a fracture of the fibula **at or about the** same level should have the upper third of the fibula X-rayed as such fractures are common.

Entire Shaft of Tibia and Fibula including ankle joint. Two views: Anteroposterior and lateral on two 14 x 17 films.

Ankle. Two views: Anteroposterior and lateral on one 10 x 12 or two 8 x 10 films. The anteroposterior view is to be made with the patient on his back, the heel resting on the plate. The lateral view is to be taken with the patient on his side, the external malleolus resting on the plate. Never attempt to show an anteroposterior view of the ankle and foot on the same plate.

Foot. Two views: Anteroposterior and lateral on one 10 x 12 film or two 8 x 10 films. Views should show tarsal and toe bones.

Os Calcis. Special view: When patient has fallen from a height and landed on his feet, in addition to the anteroposterior and lateral views described above, a plate should be made of the os calcis. This plate is best obtained with the patient lying on his back, the plate under his heel and the tube so centered that the ray will pass through the os calcis at about a fifty degree angle.

Fig. 1. Specimen blank.

by the Committee on the Treatment of Fractures of the College of Surgeons. Teachers of fractures in medical schools working with expert roentgenologists often little realize that their students will soon have an x-ray apparatus and will be trying to diagnose fractures with the x-ray. The standardized x-ray instructions have been helpful. On many railroads the films are required to be sent to the chief surgeon's office where a reading is made by the roentgenologist and returned, with the films, to the local surgeon.

Fracture report blanks have been recommended to the roads by the fracture committee. These blanks record the first aid methods used and the x-ray diagnosis and they afford space for a description of the plan of treatment of the fracture. This blank, with the roentgenograms, affords an opportunity for a consultation between the local surgeon and the chief surgeon. General directions for guidance of x-ray work in fractures are printed on the fourth page of the fracture report blank.

The fourth point in the program discussed and recommended by the committee is the follow-up and methods of obtaining improved treatment of fractures. The amount of time devoted to the teaching of fractures in medical schools has been studied. The necessity for postgraduate study has been discussed. It is agreed that fractures are emergency surgical problems and that treatment should begin at the place of injury. This means any place in the United States served by a railroad where a doctor is obtainable. Most fractures occur at busy centers, but they also occur wherever men work. The fracture committee believes that, inasmuch as there is a definite turnover in the staff of surgeons so that new ones constantly are being appointed, an educational program is indicated. The *Outline of Treatment of Fractures* adopted at the Massachusetts General Hospital Conference of 1922 was recommended for distribution to all railroad surgeons. Accordingly, the booklets have been published in large quantities and distributed. The committee also recommended other similar booklets, such as *The Primer on Fractures* published by the American Medical Association and *An Outline of The Treatment of Fractures* published by the American College of Surgeons. The centralization of fractures is recognized as highly desirable but not always feasible. At the annual meetings of the railroad surgeons, held by most of the railroads, fracture subjects are placed on the program and presented in many instances by the members and frequently by guest speakers. It should be stated here that, as a rule, the railroad surgeon in the various communities is the progressive doctor in his territory and that he is greatly interested in any help which he can obtain to improve his fracture treatment. He has learned that he is not the only one who gets bad results in fractures and he is eager to learn approved methods.

The Chief Surgeons of American Railroads are fully aware of the importance of the fracture problem and have been working on the problem individually and collectively for many years. The x-ray and other advantages and improvements of recent years have provided an added impetus to their efforts. They realize that they must begin where the medical schools leave off and assure themselves of the ability of their surgical staffs in fracture treatment. They have the advantage of close contact with the profession in every section of the country, and they not only appreciate the efforts of the various organizations working on the fracture problem, but they are desirous of co-operating with them.

# FRACTURES OF THE DORSAL AND LUMBAR VERTEBRAE

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THIS discussion is based on a review of one hundred consecutive cases of fractures of the spine treated in our private clinic. From a statistical standpoint the etiology, extent of injury, length and character of disability, and age and sex of the patient may be slightly at variance with other writers on this subject because of our geographical location and the type of our clientele. Nevertheless, deductions in general seem to correspond with the more recent literature reviewed. Limitation of time will prevent giving the statistical findings and the usual textbook review of the anatomical phases of this subject.

The same basic principles respecting treatment of fractures of the long bones apply to treatment of fractures of the spine. Therefore, we believe that the treatment should begin at the place where the injury occurred. The intelligent recognition and first aid handling of patients with fractured spines, or those who are suspected of having such an injury, bear a direct relation in many instances to the ultimate result, the amount of disability, and the ability of the patient again to resume his former occupation. The bravado of the ignorant, thoughtless first aider, who drags an automobile crash victim by the shoulders, from a wreck, with his hands in the latter's armpits, and lifts him to the sitting position, or asks the man who has fallen from a telegraph pole if he can stand up, and helps him do so, is to be condemned. Far too often inestimable damage is done by hastily shoveling a patient into the back seat of an automobile and crouching him over on his trip to the hospital, or by dragging a man by his arms and feet to the litter of an ambulance in the hurry and confusion of doing a "good turn."

An extensive personal study and a nation wide inquiry as to methods of transportation for fractures of the dorsal and lumbar spine have brought rather conclusive deductions with respect to the appropriate first aid methods and transportation used in these cases. One need not make a clinical diagnosis of fracture of the spine to suspect a back injury. The history of an automobile accident, a fall from a height through space or down a stairs, or other direct or indirect violence to the back, must always make one apprehensive of a broken back. Pain in the back after a trivial injury, twist, sprain, or lift must not be dismissed lightly, because severe vertebral damage has resulted from such torsion forces. Therefore, if the character of the injury is such that the back might have been fractured, whether the patient presents severe symptoms or not, the case is worthy of intelligent handling from the place of accident to the hospital. Of course, if paralysis of the extremities exists, the diagnosis is not difficult.

The foremost cause of fracture of the spine is the jack-knifing, forward thrust, or flexion of the trunk on itself, no matter how the force is delivered. Therefore, in rendering the initial treatment and first aid, two things are essential: First, not to increase the deformity by further jack-knifing the back and causing possible cord injury; and second, to immobilize the spine appropriately until proper treatment can be instituted. To accomplish this one should roll the patient, if he is lying on his back or side, onto a board or litter into the prone position. With his hands above the head a certain amount of support and comfort is given. If he is lifted or turned, the lower extremities, trunk, and head should be supported in the same horizontal plane. Once established on the transportation litter, whatever it be, door, plank, cot, or stretcher, in the prone position, it would be far better that he remain there until the diagnosis is made than to have him moved to the slab of a receiving ward for removal of the clothing, then to an emergency bed, later to the x-ray table, and mauled to and fro, before an adequate diagnosis is made and treatment of the fracture instituted. Of course, it is difficult to prove the amount of injury that multiple handling of a fractured back has done, but there is no reason to suppose that such fractures are different in the response to insult than fractures in other parts of the body. I realize that there are those who firmly believe that there is sufficient splinting of the fractured spine furnished by the spinal muscles to prevent further damage, that it does not make any difference whether the patient is transported on his face or on his back, on a hard or on a soft surface; but the rational of the prone position for transportation is established, and one cannot go wrong by so doing. Above all things, a person with an injured back should at no time assume a sitting posture, because that will surely

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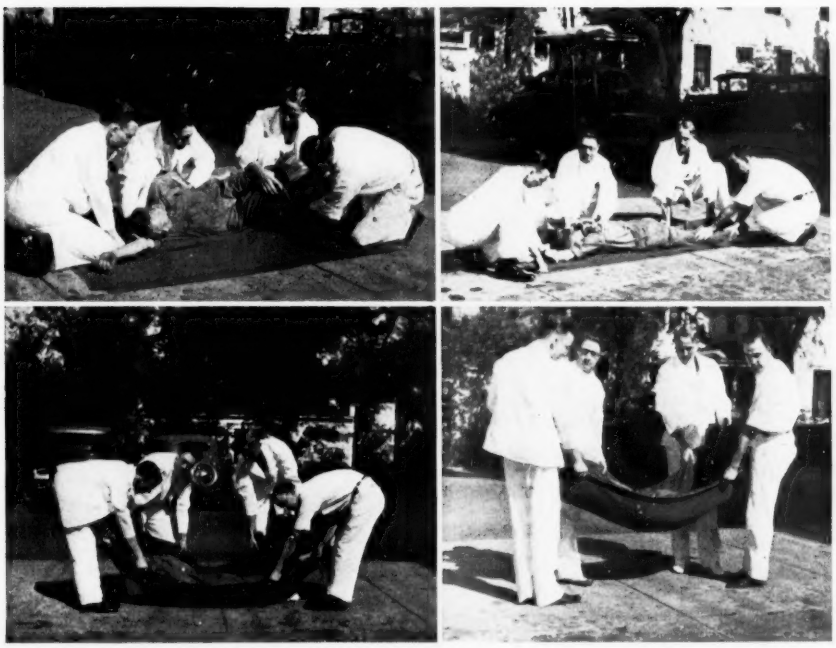

Fig. 1. A series of illustrations of the prone blanket lift for first aid care and transportation of fractures of the dorsal and lumbar spine. Upper left, at the place of accident a blanket folded long-ways is carefully spread against the injured person's body. He then should be carefully rolled from the supine position to the prone position, great care being exerted not to jack-knife the spine. Upper right, the patient on his face with the arms above the head. Lower left, four men lifting the sides and the ends of the blanket. Lower right, patient being lifted to the litter of an ambulance, or on a wide plank, door, ladder, or whatever is handy for transportation to the hospital in the prone position.

tend to increase the compression and deformity by further jack-knifing the back.

In my opinion, every suspected fracture or injury to the spine should be taken directly to a hospital where immediate roentgenograms can be taken, both in the anteroposterior and lateral positions, preferably with the patient lying in the prone position during the entire process. However, this is difficult to accomplish under the present rules of roentgen technique. I am sure that with time a technique can be developed by which the broken back will not have to be shifted from the prone to the supine position for the anteroposterior, and to the side for the lateral roentgenograms; but, rather, the patient will remain prone throughout the procedure.

The evidence of external violence in the region of the fracture or about the trunk, and the presence of a kyphosis, or deformity, are helpful in making a diagnosis, but the x-ray is of greatest value. By its vivid interpretations we recognize the fact that one may have minor and severe skeletal injuries of the spinal column without total or partial paralysis below the lesion. Unless such injuries are properly treated and recognized, prolonged and serious disability may result. In com-

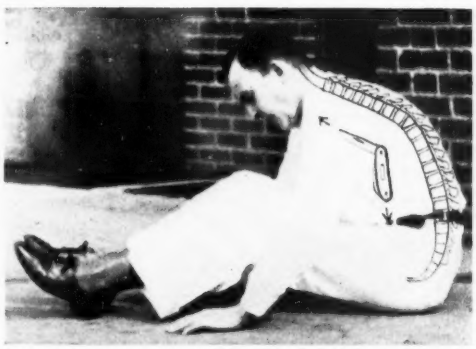

Fig. 2. Jack-knife position of the patient showing how compression of the vertebræ is increased in this position.

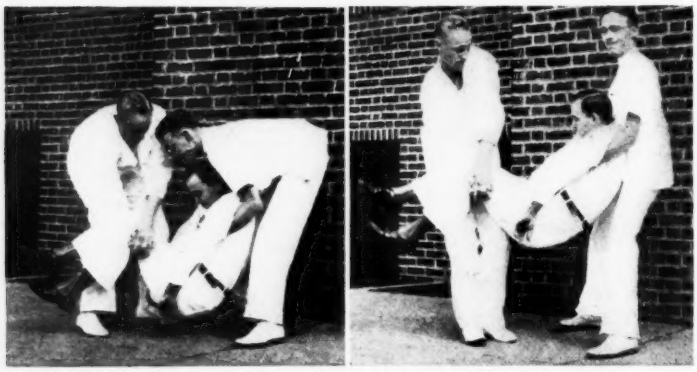

Fig. 3. Left, wrong method of lifting a patient with a fractured vertebra. Right, wrong method of carrying a patient with a fractured vertebra.

parison, relatively few fractures of the spine have cord lesions, but every fracture, or suspected fracture, should have a careful neurologic study as a part of the diagnosis; on this depends, to a certain extent, the character of treatment to be instituted. We have been impressed, in the study of our cases, with the number having injury of more than one vertebra; perhaps a major amount of compression occurs in one with a minor compression of the vertebræ above and below.

We believe that fractures without deformity should be treated by immobilization in plaster-of-paris body casts in hyperextension, and although the patient is recumbent at first, he may with time become ambulatory earlier than the patient with fracture of the spine with deformity. This is particularly true for fractures above the tenth dorsal vertebra, with or without deformity. The compensatory stability of the chest wall, with the help of the hyperextension cast, furnishes unusual support to the injured vertebræ, as the body weight and strain are transmitted to the upper and lower portions of the cast. However, compression fractures of the vertebræ below the tenth dorsal having no deformity, or with extensive wedging and fragmentation that require manual reduction, should be treated with immobilization by hyperextension corrective body casts in recumbency until the lesion is healed. Further, when there is evidence of cord injury, the pressure on the cord should be relieved by laminectomy. However, many cases of paralysis gradually clear up spontaneously or after reduction of the fracture which, in fact, relieves the pressure on the cord; but when anatomical lesions of the cord occur, the paralysis is permanent, and treatment cannot affect them. Therefore, prior to the consideration of a laminectomy, reduction of the fracture in most instances should be accomplished, to determine whether by this measure the pressure can be relieved without subjecting the patient to the additional trauma of an extensive exploratory operation.

Formerly, our treatment of fractures of the dorsal and lumbar region, without cord involvement, whether there was deformity or not, consisted of placing the patient on a hard mattress with cross boards between the springs and the mattress, moleskin adhesive plaster traction straps on both lower extremities with weights from 3 to 7½ pounds on each foot, depending on the size and weight of the patient, and the foot of the bed elevated 8 to 12 inches, to insure traction, countertraction, and relaxation of the spinal muscles. Gradual hyperextension was accomplished by means of a well padded Thomson turnbuckle hyperextension apparatus placed under the region of injury. Several times daily the turnbuckle was screwed up and the hyperextension was increased. Within 2 to 4 days we were usually able to obtain adequate hyperextension and correction of the spine. From this the patient was shifted to the prone position on a Silver hyperextension hammock, suspended on a Hawley fracture table, with special attachments for the application of the body cast. It is important to have the arms in the same plane as the trunk to prevent the scapulæ from swinging forward. This will insure a well fitting plaster-of-paris body cast about the chest. Bony prominences must be well padded, particularly the anterior superior spines of the ilii, the upper anterior chest, the spinous processes, and the upper and lower extremities of the cast. The plaster should be sufficiently heavy to allow a

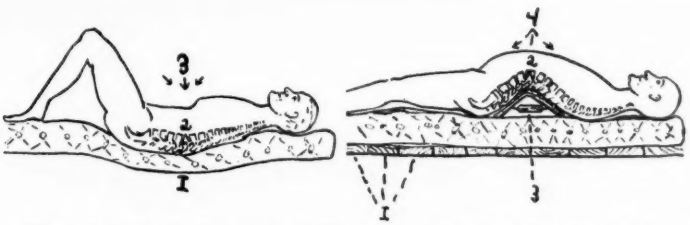


Fig. 4. Left, cartoon illustrating: *1*, The patient supine on a soft mattress; *2*, compression fracture of the vertebra; *3*, forces which tend to jack-knife the vertebra further when the patient is in the supine position. Right, cartoon illustrating: *1*, board under the mattress to prevent sagging; *2*, fractured vertebra assumes normal contour with hyperextension apparatus; *3*, hyperextension jack; *4*, illustrating the forces of corrective mechanism.

generous window over the chest and abdomen. During the setting of the cast manual pressure was made on either side of the lesion, and also against the anterior upper chest, in order that full hyperextension would be assured. In such a cast the patient could roll about in bed rather freely. We usually kept the traction on the legs for 2 weeks, then free movement in the bed was allowed for a period of 8 to 12 weeks, depending upon the severity of the fracture.

During the last few years, however, we have made early reductions of the fractures, modifying the methods of Dunlop, Davis, and others, to obtain the correction. Modified Goldthwaite irons on a frame that, by means of a turn screw device, can be shortened, thus bending upward or convexing the irons, has proved most satisfactory in reducing fractured vertebræ (Walter Johnson's modification of Goldthwaite's irons). The patient is placed supine on the well padded bars with only slight convexity, then the turn screw is tightened and the distance between the ends of the frame is shortened, thus convexing the bars and increasing hyperextension of the spine. After sufficient correction is accomplished, a plaster-of-paris cast is applied, high on the chest and low on the pelvis. When the plaster is set, the steel bars are withdrawn. As the cast is necessarily short behind, it must be high on the chest and low on the pelvis in front. When the patient is returned to bed it is necessary to support the concave portion of the cast with sand bags or pillows until the cast is perfectly dry. This type of reduction of the fracture and cast has proved, in our experience, most satisfactory, since the hyperextension is accomplished gradually without manual force or manipulation, and apparently, in most instances, this is all that is necessary to accomplish a satisfactory reduction.

Adequate sedation, and even anesthesia, is usually essential for early reduction of a fractured spine, as perfect relaxation is essential. We rather favor avertin as an anesthetic, as by its use the gastro-intestinal upset and nausea that so often follow inhalation anesthesia are not present. For short anesthesia, evipal has been used most successfully.

The only exceptions to this method of treatment are fractures of the upper dorsal regions, in which the head and neck are included in the plaster jacket, and fractures of the fourth and fifth lumbar vertebræ, which require the immobilization of the pelvis by a double spica.

After a period of from 2 to 4 weeks the patient settles down in the cast, apparently shrinks, one might say. Since we feel that a fairly tight corrective cast is an essential factor in the treatment, the cast is bivalved and the patient is carefully lifted from the posterior shell to the convex frame, the amount of convexity equaling that of the hyperextension curve of the back. Once he is on the frame the bars are further tightened to obtain full correction, and a new cast is applied.

We have tried putting some of these well corrected patients on their feet, in their casts, early; that is, after from 4 to 6 weeks. However, we have always noticed a distinct wedging and diminution of correction in the body of the vertebra, and also, often a loss of the intervertebral spaces in the region of injury. The same observation has been made in several fractures in which we have removed the cast and applied a Taylor back brace at the end of 8 weeks. As a result of these observations we are inclined to keep our patients recumbent from 8 to 12 weeks and in a body cast from 12 to 16 weeks, rather than take the chance of seeing our reduction melt away. Even with these precautions, loss has been observed, but it has not been severe, and with our exercise program conscientiously carried out during the entire course of treatment our results seem to justify these precautions. When the cast

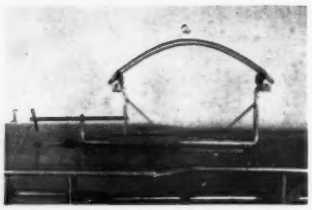

Fig. 5.

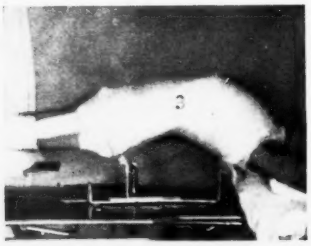

Fig. 6.

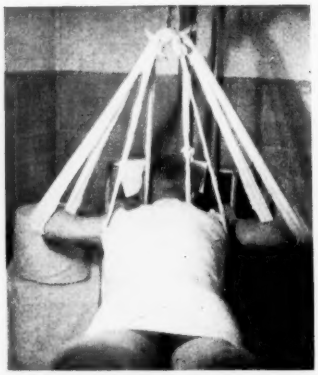

Fig. 7.

Figs. 5, 6, and 7. Three views of the Johnson-Goldthwaite hyperextension frame and bars.

Fig. 5. *1*, Turnscrew. Bars only slightly flexed or convex; *2*, the bars convexed by turnscrew.

Fig. 6. *3*, Hyperextension plaster-of-paris cast applied on the Johnson-Goldthwaite frame. The patient is turned in the prone position after the cast is dried and the iron bars removed.

Fig. 7. Hyperextension on the hammock of a Hawley table, with the arms swung up so as to bring the scapulæ close to the back, making a better fitting cast.

is removed, a well fitting Taylor back brace is applied and worn for a period of from 8 to 12 months. Whether or not the patient returns to his former occupation within that period depends on the type of work he performs and the extent of vertebral injury. It is difficult to place definite time limits in this regard. However, a man with a severe compression of the spine should not be expected to do heavy labor within 1 year from the time of his accident, no matter how good the roentgenogram looks at the end of 6 or 8 months.

The nursing care of a patient in a plaster jacket is very much simpler than that of the patient who is treated in a hyperextension frame or other similar device, and much more secure immobilization and hyperextension are obtained in the plaster jacket than in anterior and posterior plaster shells. However, if shells are deemed desirable, a bivalved plaster jacket makes the best fitting type of shell.

Standing orders for nursing care include: turning the patient several times daily; pulling the skin away from the margins of the cast twice daily, and rubbing with alcohol and powdering twice daily; adequate help when lifting the patient on and off the bedpan to prevent saturation of the cast with excretions; and the prevention of distention, which usually occurs during the first few days of hyperextension, with enemas and surgical pituitrin.

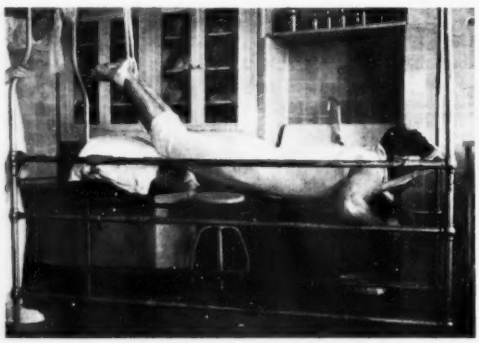

Fig. 8. Hyperextension cast applied on the Abbott frame. Hyperextension is gained by pulling the legs up. Arms resting on the side-bars bring the scapulæ in close apposition with the body.

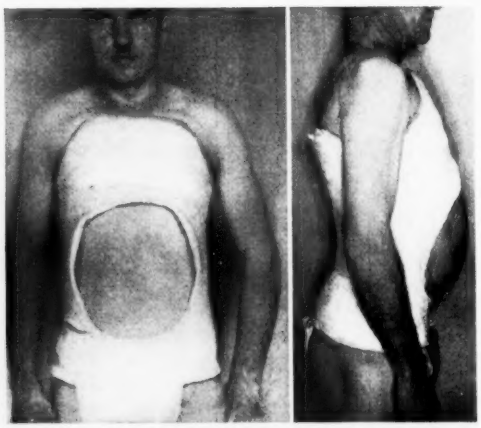

Fig. 9. Anteroposterior (left) and lateral (right) photographs of the patient in a well fitting hyperextension plaster cast with a generous window over the abdomen, high in front on the chest and low on the pelvis.

Fig. 10. Illustrative case. Left, before reduction; right, after reduction.

During the time that a patient is in the cast he is encouraged in breathing, shoulder, arm, and lower extremity exercises. Exercises while they are recumbent seem to have a very healthy effect upon the convalescence of these patients.

Fractures of the spine with paralysis, or partial paralysis below the lesion, deserve most serious consideration and experienced judgment. The Queckenstedt test for pressure on the cord should be applied in every such instance, for its value and importance cannot be overstressed. Whenever there is positive evidence of block or pressure, with no evidence in the roentgenographic examination of direct pressure on the cord by fracture of the laminæ and posterior articulating portions of the vertebra, one is warranted to perform immediately a hyperextension reduction and to apply a corrective cast or plaster bed; then bivalve the cast, make a second lumbar puncture, and apply the spinal monometer to determine whether pressure still exists. Should the pressure and block still remain, one possibly may be justified in performing a laminectomy to relieve the direct pressure on the cord at the site of injury. This should be done early, as late laminectomies are usually valueless. Continued pressure on the cord causes anatomical destruction of the substance. Of course, instead of simply a body cast the lower extremities are included in the cast in the form of a double spica or plaster bed. The back of the head, as well, may be included. Care of the bladder and bowels in such cases is of grave importance. Although there is a general feeling among surgeons that the cord bladder is adequate for such cases, many of our leading urologists feel that suprapubic cystotomy performed early lends greatly to the future happiness of the permanently paralyzed patient, and gives less opportunity for infection to ascend to the kidney. My meager experience with such cases seems to bear out this deduction.

Fractures of the transverse processes, with symptoms of back pain and discomfort, are treated by adhesive plaster strapping for a few weeks. However, with a history of a rather serious injury or evidence of violence we have occasionally placed the patient in plaster casts for a few weeks and then applied adhesive strapping. These injuries are usually not serious, nor should they cause disabilities.

Hypertrophic arthritis has proved to be our most annoying complication, and we believe that it has been responsible for the greatest amount of disability. The loss of the intervertebral space and slight or moderate deformity, as well as advancing years, seemed to be contributing factors to this complication.

## CONCLUSIONS

1. The treatment of a patient having, or suspected of having, a fractured dorsal or lumbar spine should begin at the place of accident, as

this may bear a direct relation to the ultimate disability.

2. The prone position for transportation tends to hyperextend the spine and thereby prevents increasing the kyphosis deformity.

3. The reduction of fractured vertebræ by gradual hyperextension has an established place in the treatment, but early direct reduction under anesthesia is believed preferable.

4. A hyperextension plaster-of-paris body cast furnishes the most adequate method of immobilization of a fractured spine.

5. A period of 8 to 12 weeks in recumbency and 12 to 16 weeks in a cast, followed by a Taylor back brace for 8 to 12 months, seems to give the best results.

6. Exercises during recumbency have a good influence on the convalescence.

7. Meticulous nursing care adds to the patient's comfort and well being.

8. Laminectomy should be considered only when evidence of pressure or block persists after reduction of the fracture.

9. Advancing years, vertebral deformity, and hypertrophic arthritis have a definite influence on the amount of disability.

# COMMON FRACTURES ABOUT THE ELBOW JOINT IN CHILDREN

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FRACTURES about the elbow joint in children are interesting from the standpoint of diagnosis as well as treatment. In spite of x-ray evidence mistakes are often made; without it errors are inevitable. The chief reason for this seems to be that the normal appearances vary greatly with the age of the child and, to a lesser degree, with the osseous development. From Figure 1 it is evident how readily the inexperienced may be deceived.

My plea in this communication is that most fractures about the elbow joint in children call for operative treatment. Unfortunately, the almost universal teaching about these injuries, that they are effectively treated by hyperflexion, has led to atrocious results. Even in large institutions where treatment might be controlled by roentgenography, this erroneous doctrine is often adopted (Figs. 2, 3, 4). Manipulation under the screen may reduce the number of cases demanding open operation, but in children so much of the displaced parts is invisible that a fallacious confidence is apt to be engendered.

From the Royal Hospital for Sick Children.

Presented in the Symposium on Fractures, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

The commonest fracture at the lower end of the humerus is what is called the extension fracture, and it seems logically correct to suppose that hyperflexion will control this lesion. To be effective, flexion must be pronounced, and in a swollen arm there is great risk of inducing a Volkmann's ischemic contracture. Even the law courts will not tolerate this complication as in any case inevitable and nonculpable. No amount of flexion will release from the penetrated soft parts the entrapped expanded lower end of the humerus. To get the best view in the screen the elbow must be extended, and on flexing it after manipulation a displacement is apt to recur as the configuration of the fracture line lends itself to instability. If this extension view be omitted, it is impossible to know whether a cubitus varus or valgus may be hidden by the flexion, just as a genu valgum or varum is masked by flexion of the knee (Figs. 5 and 6). The specious excuse that the deformity has arisen from damage sustained at the time of the accident by the epiphysis is fortunately usually accepted. Alas for this very present help in time of trouble. A separation of an epiphysis is seldom followed by a deflection in the alinement because the separation takes place beyond the growing line. The

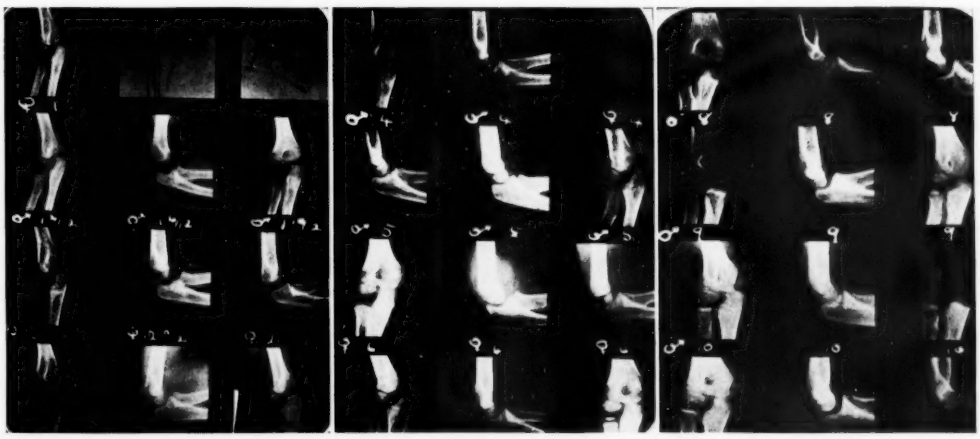

Fig. 1. Roentgenograms of elbow joints at various ages.

Fig. 2.

Fig. 3.

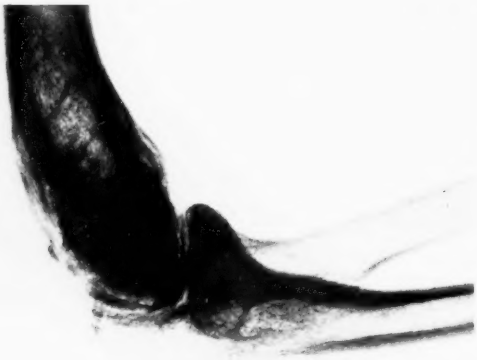

Fig. 4.

Fig. 2. Healed extension fracture; treated by flexion.
Fig. 3. Same case as in Figure 2 after removal of the upper fragment projection.
Fig. 4. Ten years ago fracture of the humerus was treated by flexion. Complete ankylosis. Two months later open operation showed lower articular surface inverted. Postoperative treatment neglected; range of movement 29 degrees.

cubitus is found fully developed and fixed in degree immediately the elbow has recovered sufficiently to permit of extension; this unmasks the deformity established at the time of the accident.

Flexion fractures are not so very uncommon. In them the external appearances of the elbow may closely simulate those of the extension type, and if treated by flexion the displacement can only be aggravated (Fig. 7).

It may be at once admitted that limitation of movement at the joint is principally due to incomplete or faulty setting of the fracture. A loophole in this damaging statement may be found in the occasional occurrence of loose bodies in the joint, either alone or associated with a traumatic myositis ossificans (Figs. 8, 9). Loose bodies in the elbow joint are rare and give rise, for obvious reasons, to disabilities incomparably less extensive than those found in the knee.

The very common fracture through the capitellar surface cannot have its reduction achieved by the best manipulation or the most extreme flexion.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. Outline of arm in cubitus varus.
Fig. 6. When folded, varus disappears.
Fig. 7. Consolidated flexion fracture after treatment by flexion.

### TECHNIQUE

I will now pass on to consider how the various fractures are dealt with in my own practice, not as an example of egotism but to make this communication entirely personal and incidentally thereby to drastically curtail it.

*Humerus.* A fracture immediately above the joint is the one specially suitable for treatment by manipulation, but if not completely reduced, limitation in movement or a cubitus may remain. Its treatment so far as I am concerned is the same as the more common fracture which is wholly or partly intra-articular; it extends through the coronoid and olecranon fossas but is entirely above the epiphysis. Where the displacement is marked, the upper fragment penetrates the soft structures anteriorly and its reduction under open operation is often so difficult that I am skeptical about the claims of those who advocate manipulation even with the aid of the screen.

The treatment of cubitus varus first interested me in fractures about the elbow joint. The procedure adopted was published in the *Practitioner* for August, 1910. It may suffice to say that a movable varus is fully controlled, with the elbow

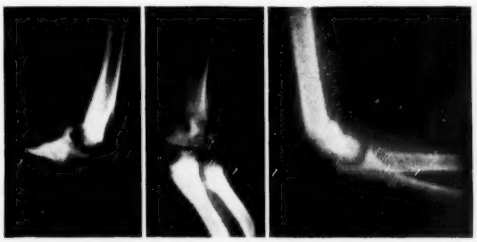

Fig. 8, left. Injury years ago. Flexion reduced by 27 degrees. Six loose bodies removed by operation; several visible in skiagram.

Fig. 9. So called traumatic myositis ossificans.

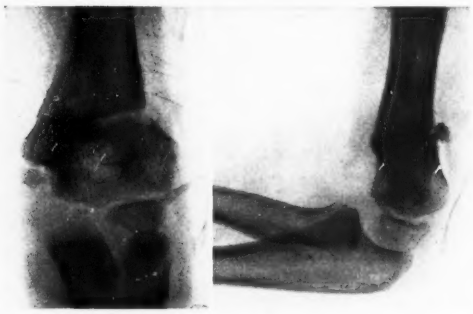

Fig. 10, left. Cubitus varus after cuneiform osteotomy; position retained by hyperpronation. Front view.

Fig. 11. Same case as in Figure 10; side view.

flexed at a right angle, by hyperpronation, while hypersupination corrects the corresponding valgus deformity. In late cases (Figs. 10 and 11) a cuneiform osteotomy is done without wiring, retention being achieved by hyperpronation or supination, as required.

As experience has accumulated, I am more and more convinced that the results of open operation give by far the best results. When the case has been placed in the operative category the procedure is carried out as soon as possible, certainly within a week of the accident. It is unfortunately a very common experience to have these cases sent for treatment months or even years after the accident to have something done to reduce the disability, but in such circumstances all that can be done is a salvage operation. On account of the swelling which rapidly occurs after the injury, the bony landmarks become more or less obliterated, but the incisions should be capable of location with sufficient accuracy. As a rule a tourniquet is applied to the arm. The external incision is made first; it is practically the Kocher incision. The abrupted area will soon be reached and should be cleared of débris. At this situation the fracture line is almost always extra-articular and the joint should be opened anteriorly by raising the tissues from the lower fragment, but this process should not be carried downward unnecessarily as the vitality of the lower fragment may be impaired. To disentangle the expanded lower end of the upper fragment may require considerable force and even some division of tissue.

When the lay of the land has been ascertained, the internal incision may be made. The periosteal elevator or other instrument is pushed across the hole in the arm to make the skin project on the inner side. The incision is made in this situation. The ulnar nerve is directly in the way so should be intentionally exposed to avoid accidental injury. Where only the capitellar surface has been separated an internal incision is unnecessary, but if the fracture extends to the inner side, the inner incision is essential.

The lower fragment should now be fitted to the upper. It is a cardinal part of the general technique in open operations on fractures that the hands be kept out of the wound, but in this fracture such restriction may be relaxed with advantage, for unless the reposition be accurate the operation need not be undertaken at all. To ensure the best possible correction sight is not enough, and I have found that by placing one finger in front and another behind the fracture line a truer apposition may be secured than by sight alone. In delayed operations, on account of the superabundant callus or new bone, it may be very difficult to identify the original fracture line, and it may be necessary to trust to luck when we create such a line. Having steadied the lower

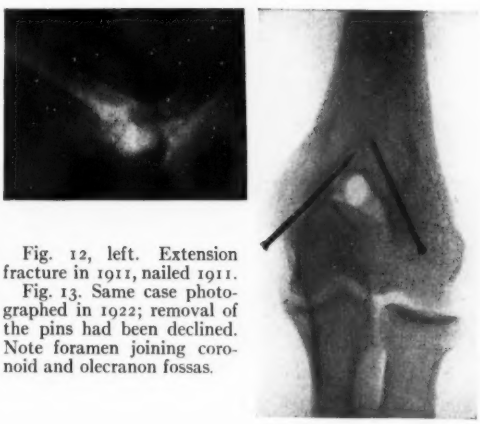

Fig. 12, left. Extension fracture in 1911, nailed 1911.

Fig. 13. Same case photographed in 1922; removal of the pins had been declined. Note foramen joining coronoid and olecranon fossas.

Fig. 14. Fig. 15. Fig. 16. Fig. 17.

Fig. 14. Extension fracture.
Fig. 15. Same case as shown in Figure 14 after manipulation and flexion.
Fig. 16. Same case as shown in Figure 14 after pinning.
Fig. 17. Same case as shown in Figure 14 after lapse of 3 months.

fragment in its correct contact with the upper fragment, a hole is bored by an awl through it and into the upper fragment. Skill, or it may be luck, exists in this maneuver. The awl is left in position while the inner side is given attention. It sometimes becomes a puzzle to get both sides to lie in equally good position. Some exaggeration of the forward slant of the articular surface is less serious than the reverse, excess flexion being preferable to excess extension at the expense of reduced flexion.

As the awl is being withdrawn its point of emergence and direction should be meticulously observed, as the soft tissues at once hide the hole. A round French wire nail is then hammered down the tract of the awl. To avoid injury from the hammer a nail punch may be used as an intermediary. If the nail be too long or its direction wrong, it will either perforate the shaft of the humerus or bend on the hard surface of the cortex, the latter feature being preferable to the perforation, though a little projection of the point does not signify. It is a mistake to trust for secure fixation to one nail on the outer and usually most displaced section; both sides should be secured. Again the ideal asepsis should be risked by guiding the awl across the line of fracture by the finger or fingers.

Before the joint is closed, flexion and extension should be gently performed; an error will possibly be disclosed by detection of straining on one or both pins. These nails are purposely not driven into a sunken position, but their heads are left projecting, and before the wound is closed a small cross is made by the knife on the skin over the palpable projection of the nail head. When the nails are due for removal (in about 2 months), this mark will greatly facilitate their expeditious extraction. The wound is closed in two layers; a splint is not required as the inspissated discharge in the dressing forms an adequate support (Figs. 12 and 13).

The foramen in the humerus was not artificially produced and its presence has been taken

Fig. 18. Compound fracture in childhood; treated by the late Sir William Macewen; function excellent but pain down ulnar nerve.

Fig. 19. Fracture of the internal epicondyle, etc; fragment displaced into joint; fracture of neck of radius not requiring treatment.
Fig. 20. Same case as in Figure 19 after pinning.

Fig. 21.

Fig. 22.

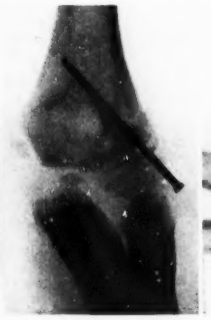

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 28.

Fig. 21. Fracture of capitellar surface; front view.
Fig. 22. Same case as in Figure 21; lateral view.
Fig. 23. Same case as in Figure 21 after pinning; front view.
Fig. 24. Same case as in Figure 21 after pinning; side view.
Fig. 25. After pins removed; front view.
Fig. 26. Same case as in Figure 21 after pins removed; side view.
Fig. 27. Capitellar fracture.
Fig. 28. Same case as in Figure 27 6 years later; pins still *in situ*.

as a hint of how the range of movement may be increased should the fossas be found more or less obliterated by callus (Figs. 14, 15, 16, 17).

The usual after-treatment may be carried out but the continuous unconscious movements and use of the arm by the child constitute the most effective part of the after regimen. Were it not for this providential circumstance the results of such fractures, however treated, would be infinitely worse than they are.

These fractures are frequently complicated by ulnar or median nerve paralysis. After reduction the paralytic element usually disappears, but in some a nerve lesion develops as a late result, even after the lapse of years (Fig. 18). In the case of the ulnar nerve its transplantation anteriorly is usually found satisfactory.

Though my contention that transverse fractures of the lower end of the humerus are best treated by open operation is debatable, I have no hesitation in asserting more emphatically that

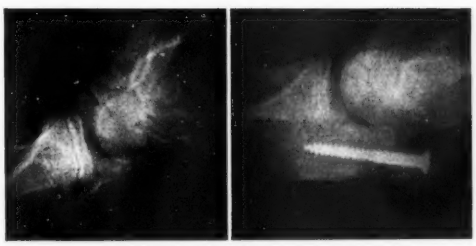

Fig. 29, left. Fracture of olecranon.
Fig. 30. Same case as in Figure 29; screw inserted in 1912, later removed.

Fig. 31, left. Fracture of the neck of radius; front view.
Fig. 32. Same case as in Figure 31, nail through head down shaft; not removed.

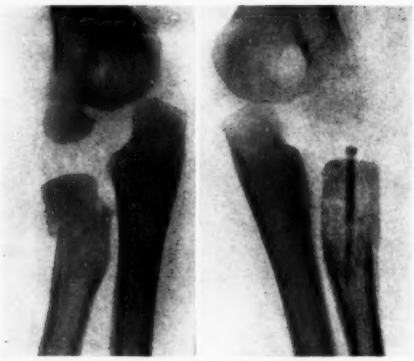

Fig. 33, left. Fracture of the neck of radius.
Fig. 34. Same case as in Figure 33 with bone nail inserted.

the displacements associated with fracture of the internal and external condyles require fixation by open operation. The displacement of the detached internal epicondyle, with more or less of a fragment of the trochlear surface, is peculiar and not as widely known as it should be (Figs. 19 and 20). The fragment descends and turns anatomically outward, becoming wedged between the ulna and the remaining trochlear surface. The operative reposition and fixation of the fragment is easy and satisfactory. The corresponding fracture of the outer side is extremely common; its treatment without operative fixation is disastrous. The displacement, unlike that of the inner side, is logical; the lower fragment is pulled downward while the broken surface is turned forward. If there be any special difficulty in replacing the complete transverse fracture, such difficulty is always present, and with the lapse of time it may be impossible to restore the fragment to its proper place. Two nails may be required.

*Olecranon.* Where open operation is necessary, the upper fragment should be screwed down by an ordinary wood screw (Figs. 29, 30). The triceps tendon is incised and the drill is inserted. The fragments should be in alinement before the drill reaches the shaft. If well placed, the lower fragment need not be drilled at all, as the screw will have all the firmer hold by threading or tapping its own track. Splinting is unnecessary and movements may be started in a few days.

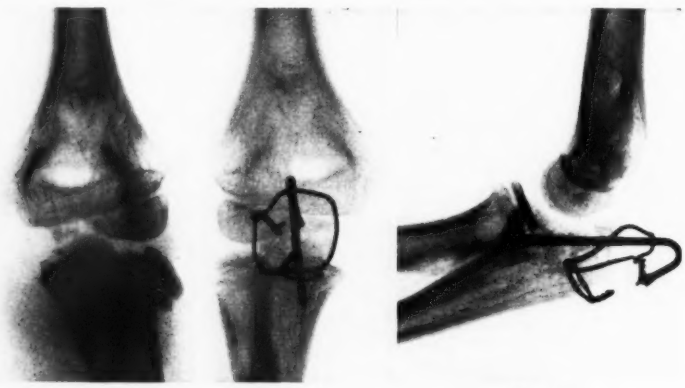

Fig. 35. Fig. 36. Fig. 37.

Fig. 35. Fracture of the neck of the radius.
Fig. 36. Same case as in Figure 35 after reduction without fixation; ulna nailed and wired because vertical crack prevented insertion of screw nail.
Fig. 37. Same case as in Figure 35; side view.

*Radius*. A fixed displacement of the head of the radius is apt to be very disabling to rotation of the forearm. Open operation in these cases is hopeful. Formerly I employed the Kocher incision, but was dissatisfied with the exposure. It was also difficult to perceive when the requisite correction of the displaced head of the radius had been achieved. A thin wire nail was then driven through the head and down the shaft of the radius (Figs. 31, 32).

The procedure now adopted to expose the joint surface is that introduced by Schlange; it gives a vertical view of the lower elbow joint. A transverse incision is made across the elbow to expose the upper end of the ulna. The wound is retracted upward to expose the olecranon and allow it to be correctly drilled previous to its being either sawed through or divided by osteotomy. Complete flexion then allows the making of an exact estimate of the amount of the displacement. The head of the radius may be found detached in whole or in part; in children, as a rule, the neck is merely bent in the greenstick fashion. The severed head is pinned down by bone tack or screw as this obviates (Figs. 33 and 34) the removal of a foreign body later on. If the neck be bent, it is straightened, often without loosening the fracture. If there is a tendency for the displacement to recur, a bone nail will retain the correction. The severed top of the olecranon is now screwed to the shaft as for a fracture. The wound is closed in two layers and the usual after-treatment is instituted. Passive movements may be started in a few days. The screw in the elbow is removed as usual. The results of this operation have been highly satisfactory.

SUMMARY

1. In children most fractures about the elbow joint with displacement require open operation.

2. Treatment by flexion risks a Volkmann's contracture.

3. When the lower end of the upper fragment is caught in the soft tissues, manipulation cannot always release it; flexion is useless.

4. Manipulation under a screen requires the elbow to be viewed in extended position; displacement recurs on flexion. If it be not extended, a cubitus may be present and missed.

5. Flexion fractures are made worse by flexion.

6. Limitation of movement is due to incomplete setting, except where loose bodies form or a traumatic myositis ossificans develops.

7. Capitellar displacements are neither reduced nor retained by flexion.

8. Varus may be controlled by hyperpronation; valgus, by hypersupination.

9. Transverse fractures of the humerus are nailed on each side; trochlear and capitellar, on one side only.

10. Olecranon fractures are screwed into position by a wood screw.

11. Fractures of the neck of the radius are nailed from above after the joint is opened by the Schlange[1] method.

[1]Schlange. Arch. f. klin. Chir., 1906, 81: 9-32.

# FRACTURES OF THE BONES OF THE FOOT—EXCEPT THE OS CALCIS

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DISABILITIES due to malalinements with disturbances in weight bearing lines following fractures of the bones of the foot are fairly common. Many fractures of the foot go undiagnosed because roentgenograms are not made. This is particularly true of fractures of the phalanges and the metatarsals, because physical signs and disability are comparatively slight. The majority of such fractures need no special treatment because displacement of the fragments in the metatarsals is usually not great, and the fractures of the phalanges are usually due to crushing injuries accompanied by comparatively little displacement. Fractures of the tarsals, particularly the astragalus, produce more serious disability and roentgenograms are more often made.

## ANATOMY

The foot depends for its strength on the arrangement of bones, supported chiefly by ligaments, in the shape of half a dome with the heel for one end and the heads of the metatarsals for the other, the outer border of the foot being the edge of the dome. This arrangement has also been likened to a triangle from the os calcis posteriorly to the heads of the first and fifth metatarsals anteriorly. The longitudinal arch along the inner border of the foot is an arch in actuality and has a definite function to perform, but the so called anterior arch is in no sense of the word an arch; it does not act as such, and exists only in textbooks. Flexion and extension take place at the astragalotibial joint, lateral motion in the astragalocalcaneal joint; increased lateral motion, really consisting of inversion and eversion, on the other hand, takes place in the tarsal joints. It is when fractures so alter the contour and articulating surface of the bones that these movements are limited that disability results.

## ETIOLOGY

Fractures of the phalanges are always due to direct trauma, but those of the metatarsals may be caused either by slight direct trauma or by indirect violence. Fractures of the cuboid and cuneiform bones are generally incident to a fall with the foot in plantar flexion, with twisting of the foot internally or externally. Direct violence, such as from falling objects or from crushing by wagon or automobile wheels, also may be the cause. The scaphoid bone likewise is usually fractured by force as the result of a fall with the foot in plantar flexion, the bone being compressed between the cuneiform and the head of the astragalus. Fractures of the astragalus are usually sustained by falls from a height with the knees held stiff and are often associated with fractures of the os calcis. If the os calcis also gives way, the astragalar fracture is usually not as severe in type as it is when the full force is spent on the astragalus.

## DIFFERENTIAL DIAGNOSIS

Differential diagnosis would seem not to be difficult, but certain supernumerary bones seen in the roentgenograms are occasionally interpreted as fractures, particularly by those not accustomed to reading roentgenograms of the foot. The os trigonum, lying at the posterior tip of the astragalus (Fig. 1); the os peroneum (Fig. 2), lying on the outer side just posterior to the head of the fifth metatarsal; and the accessory scaphoid, lying to the inner side and inferior to the inner side of the scaphoid (Fig. 3), are the common offenders. Normally there are two sesamoid bones in the flexor tendons just beneath the head of the first metatarsal. Occasionally one of these, usually the inner, is congenitally divided (bipartite) and casts a double shadow in the roentgenogram and may be mistaken for a fracture of the sesamoid (Fig. 4).

A fracture sometimes mistaken for a neoplasm is the so called "marching fracture" of the metatarsal bones (Fig. 5). It may occur without obvious trauma and with little immediate pain. Weeks later a developing callus becomes painful, roentgenograms are taken, and the suspicion of malignancy is aroused. It is thought to occur when the long tendons of the toes and the intrinsic muscles of the foot are exhausted and fail to give their normal support to the bone. The second, third, and fourth metatarsals, in the order named, are involved most frequently in this type of fracture.

From the Section on Orthopedic Surgery, The Mayo Clinic.
Presented in the Fracture Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

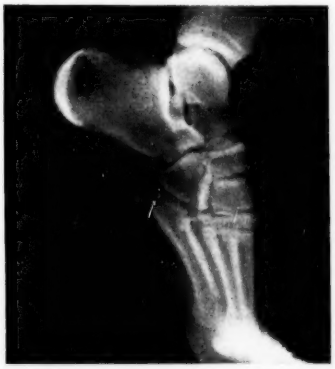

Fig. 1. The os trigonum at the posterior tip of the astragalus.

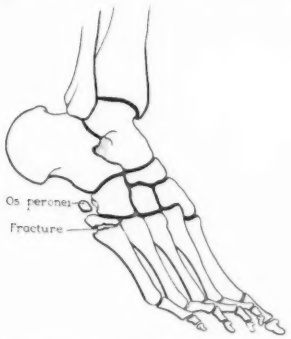


Fig. 2. Fracture of base of fifth metatarsal and os peroneum.

TREATMENT

There are certain general principles in treating fractures of the foot that should be kept in mind: First, bony displacements due to dislocations, fractures, or both, should be corrected at once to prevent further disturbances in weight bearing lines. Manual molding with the patient anesthetized usually suffices to correct this condition, and the application of a snug fitting cast is sufficient to maintain it. If a cast is used, the circulation must be closely watched because ischemic paralysis may follow interference with the venous return, just as happens in the hand and forearm. At the first sign of this, the cast must be split and loosened even at the expense of loss of position. Second, if the injury is so extensive that correction by molding cannot be attained, open operation is indicated and arthrodesis of the involved joints is advisable to restore the contour and weight bearing line. Arthrodesis should be resorted to as soon as marked swelling and the effusion have subsided. Third, bony prominences that project into the plantar surface are especially to be avoided and, when present after the fracture is healed, should be promptly smoothed down by chiselling. Though not as important, prominences that project dorsally sufficiently to cause irritation by the shoes must be guarded against, and when troublesome, should be treated in the same manner.

*Fractures of the phalanges and metatarsals.* Fractures of the phalanges rarely produce any great displacement of fragments and they can be treated by bandaging the fractured toe to the sound one next to it. Traction by means of a banjo splint with drilling of the toe nail for traction may be used, but usually is not necessary.

Fig. 3. Accessory scaphoid bones in both feet.

Fig. 4. Congenitally divided sesamoid bone beneath head of first metatarsal.

Fig. 5. Marching fracture of third metatarsal.

Metatarsal fractures should be treated with the purpose in view of preventing the formation of bony prominences in the sole or dorsally. The fractured fragments should be forced upward and held by a pad until united. Lateral displacement of the fragments is of little consequence and can usually be disregarded. The so called marching fracture of the metatarsals is seen late and should not be interfered with. As the exuberant callus matures, it solidifies and shrinks until, years later, it is difficult to detect any evidence of a fracture. Fracture of the base of the fifth metatarsal (Fig. 2) is fairly common; it is commonly caused by indirect violence with the foot in inversion while the heel is raised and the weight is on the foot; it may be produced by direct violence. No special treatment is necessary, rest sufficing.

*Fractures of the cuboid, cuneiforms, and scaphoid.* Fractures of the bones of the midportion of the foot are often due to direct violence and treatment should be directed to forcing the fractured and compressed bones back into their normal place in the arch. Considerable force may be necessary and the Thomas wrench is a great aid. If this is not done, malunion will occur, with the resulting rigid flat foot, and at a later date some form of osteotomy and arthrodesing procedure of the involved joints will be necessary.

*Fractures of the astragalus.* Fractures of the astragalus often leave in their wake very serious disability. Severe sprains involving the external lateral ligament may cause a chip of the astragalus to be avulsed, and this should be treated not as a fracture but as a sprain. While fractures of the posterior trigonal process of the astragalus are, I believe, extremely rare, they are of importance, particularly in industrial and medicolegal practice, because, as pointed out by Philip Wilson, in about 10 per cent of individuals the ossification center of the trigonal process remains separate and forms a separate bone, the os trigonum. Wilson acknowledged the rarity of fractures of the trigonal process and intimated that one or more of his own three cases might not have been true fractures.

No treatment is necessary except rest with the foot at a right angle for several weeks. The "check" fracture is disabling because of the formation of an exostosis at the line of contact of the anterior margin of the tibia with the upper part of the neck of the astragalus. It is usually not recognized until late, when the ridge is well formed. If the condition causes much pain, some appreciable relief can be afforded by chiselling this ridge away. Active motion must be instituted promptly after the operative trauma has subsided. Wilson suggested that arthrodesis of the tibio-astragalar joint may be necessary, but I have never done it. The foot is an adaptive member and will gradually adjust itself to many irregularities if given time.

Inasmuch as fractures of the os calcis are not to be considered in this paper, I will not discuss the painful arthritis that may follow fractures involv-

Fig. 6. Fracture occurring through the neck of the astragalus.

Fig. 7. Same as Figure 6 after reduction and fixation with beef bone screw.

ing the astragalocalcaneal joint following injuries, either of the os calcis, of the astragalus, or both, except to remark that if there is marked distortion of this joint, arthrodesis should be done early rather than late. Although arthrodesis obliterates lateral motion of the posterior part of the foot, function of the foot as a whole is interfered with surprisingly little.

The most troublesome to treat, and the fracture of the astragalus leaving in its wake the greatest disability, is the transverse fracture through the neck of the bone with either posterior or inward displacement of the body (Figs. 6 and 7). There may be rotation of the body so that it rests at right angles to its normal position (Fig. 8). Great swelling and disability follow immediately. The only treatment is to open the joint wide and put the fragments back in place. A beef bone peg or screw, or even fixation with a long metal nail that can be later removed, may be necessary. I have seen several cases in which nearly normal function was restored by these means. Astragalectomy may have to be resorted to, and if so, the foot must be displaced well backward or function will be very poor. Fractures of the astragalus of this type cause varying degrees of permanent disability and the prognosis should be guarded.

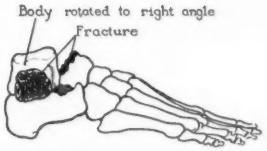


Fig. 8. Fracture through neck of astragalus with rotation and displacement of body of astragalus.

## CONCLUSIONS

Bones of the foot other than the os calcis which, in so far as seriousness and possible disability from their fracture are concerned, in their order of importance are: the astragalus, scaphoid, cuneiform, cuboid, metatarsals, and phalanges. Fractures of the tarsals often require open surgical measures, either early or late. Fractures of the phalanges and metatarsals rarely do and can usually be treated conservatively. Considerable discomfort consequent to fractures of the foot lingers for many months and even years, but it is surprising how many patients ultimately attain good function with little pain.

## REFERENCE

WILSON, P. D. Fractures and dislocations of the tarsal bones. South. M. J., 1933, 26: 833–845.

# SYMPOSIUM ON CANCER

## AN OCCUPATIONAL STUDY OF CANCER OF THE EYE AND ADNEXA

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THE medical literature of Great Britain, Germany, and to a lesser extent that of America,[1] contains articles dealing with occupational cancer. Careful search of the literature does not reveal any specific articles dealing with occupational cancer of the eye and adnexa. In only two occupational reports of cancer in general is mention made of eye and eyelid cases, namely by Kennaway, who found 11 cases of eye and eyelid epitheliomas among 100 pitch workers, and 2 cases among 33 tar workers. Among 38 persons who had 75 cancers due to arsenic he found only one eyelid case.

Haagensen found 208 eye cancers (not all were verified by biopsy) among 21,510 patients suffering with neoplastic disease who sought treatment at Memorial Hospital, New York City, during a period of 13 years.

For quite some time the writer has been making a study of tumors of the eye in connection with radiotherapy of the same. The literature is limited and the reports are often very incomplete; hence in making this occupational study it appeared that fuller and more accurate data might be obtained by actual study of a large number of eye tumor records in: (1) clinics and institutions devoted to the treatment of the eye; (2) those devoted to the study and treatment of malignant disease; and (3) the medical services of large industrial plants where a possible cancer irritant hazard might exist.

### NUMBER OF CASES IN THIS REPORT

This method of gathering the necessary data has proved exceedingly informative. One thousand cases form the basis of the statistical part of this study. A biopsy or a microscopic examination of the tumor has been made in every case and the cases have been followed up.

### NEOPLASTIC GROUPING OF THE CASES

The cancer of the eye records chosen for this study were grouped under the two principal malignant tumor classifications, namely: the sarcomas or connective tissue type and the carcinomas or epithelial type. The 1,000 cases are equally distributed in each classification.

All other malignant tumors involving the eye and adnexa occur very rarely and are not, therefore, of great importance in an occupational study. The retinoblastomas occurring in childhood mostly before 8 years do not present an occupational problem; therefore they do not concern us in this study except as appears under the heading, "Is Cancer of the Eye on the Increase?"

### SOURCES OF MATERIAL USED IN THE STUDY

The material used in this study has been obtained as follows:

(1) From the records of the eye departments of 28 leading eye clinics in different parts of the United States and Canada; (2) From the records of four institutions devoted exclusively to the study and treatment of cancer; (3) From the private records of many eminent ophthalmologists; (4) From the medical services of 10 large industrial plants producing chemicals, oils, carbon products and gas; (5) From the Army Medical Museum Collection of eye tumors.

### DIFFICULTIES IN SECURING OCCUPATIONAL DATA

Hundreds of cancer records in eye clinics and ophthalmologists' offices failed to state patient's occupation and address, or to record the pathological report. Such records are worthless in this type of study. Cross indices, except in two clinics, were entirely lacking. In one of our early surveys 100,000 pathological records of all kinds of tissue had to be gone over to get the eye tumor cases. Only 48 sarcoma and 14 carcinoma cases could be used.

Another important difficulty was the lack of follow-up work. No eye clinic (Army eye pathological collection excepted) had a tumor follow-up system. In the institutions for the study and treatment of malignant disease the records were much better. Good follow-up prevailed, some systems having been in use more than 5 years. Most of the eye cases in these institutions were of

From the Department of Ophthalmology, University of Michigan.
Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

the carcinoma type. Seldom are the sarcomas, especially the malignant melanoblastomas, referred for roentgen treatment.

From data gathered in this study and from many reports in the literature extending over a long period, it appears that the ophthalmologist is making a mistake not to employ radiotherapy either alone or combined with surgery in all malignancies of the eye. Longer freedom from recurrence and metastasis exists in irradiated cases.

### IMPORTANCE OF FULL OCCUPATIONAL DETAILS

It is exceedingly important to know how long the patient has followed his occupation at the time the cancer appeared, likewise, whether any other occupation was previously followed and if so, how long. These questions often have an important medicolegal bearing. Nearly all records failed to record this data. Instances are found in the literature and in the survey material in which a patient suffering with a cancer had changed his occupation. This change in occupation had for a time led to a decrease in the growth. Such a case should be classed under the primary occupation and is not entitled to compensation.

The exact nature of the duties of the occupation need to be known. Is the patient working more or less constantly with known cancer irritants? In general cancer work it is now recognized that an increased cancer incidence exists in those occupations involving chronic irritation and prolonged exposure to aniline, anthracene, arsenic, creosote, paraffin, petrolatum, pitch and tar, radium and roentgen rays, shale oil, soot, and sunlight.

As a rule it takes from 10 to 15 years' exposure to an irritant before precancerous and cancerous lesions develop. Before passing on to the classification of the occupations, a plea is made that every person taking a cancer history get a complete and full history of the patient. Details are of importance in solving the cancer problem.

### LACK OF OFFICIAL OCCUPATIONAL CANCER STATISTICS

In studying the eye cancer records of clinics and in obtaining data from the various industrial plants representing more than 50,000 employees, there has been some difficulty in condensing and grouping more than 150 different occupations.

Official occupational mortality statistics, tables of age distribution in occupations, and cancer morbidity rates, except in a few states and in the Metropolitan Life Insurance Company data, are not available in this country.

The only reference to mortality rates by occupational class in the United States is a brief presentation by R. H. Britten, in 1934[1]. This report was based on data derived from the United States Census Bureau, 1930. It covered 10 states only. Britten's occupational report concerns men only and does not give the number in specific occupations.

TABLE I.—OCCUPATIONAL GROUP I EXPOSED TO OILS AND LUBRICANTS

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Automotive occupations | 6 | Automotive occupations | 9 |
| Machinist, mechanic | 6 | Machinist, mechanic | 6 |
| Mechanical engineer | 1 | | |
| Oil station attendant | 2 | Oil-lubricant handler | 1 |
| Plumber—steamfitter | 2 | | |
| Printer | 1 | Printer | 3 |
| Total | 18 | Total | 19 |
| Total of all cases of both types | | | 37 |

### OCCUPATIONAL GROUPS

After considerable study of the survey material and perusal of the literature, the data has been placed in seven groups as follows:

Group I. Occupational groups exposed to oils and lubricants.

Group II. Occupational groups exposed to sunlight and the elements.

Group III. Occupational groups exposed to chemicals.

Group IV. Occupational groups exposed to (a) coal (b) pitch and tar.

Group V. Occupational groups exposed to radioactive substances, such as radium and roentgen-rays.

Group VI. A large group of miscellaneous occupations, such as clerical, construction, domestic and personal, engineering, professional, transportation, public service, and trades including businessmen, merchants, and sales people.

Group VII. A comparatively small group of workers in metals.

### OCCUPATIONAL SURVEY TABLES OF 1,000 CASES

A striking similarity in the occupations of each type of cancer in group I is noted (Table I). There is also a nearly identical number of cases in each tumor type. A total of 37 cases per 1,000 is high. It indicates an increased cancer distribution among those whose occupations expose them to oils and lubricants. The general cancer rate is 8 for females and 11 for males per thousand.

The literature indicates that oils produced in the United States, except in the midwest region where oils have a higher paraffin and asphalt base, do not have as high carcinogenic properties as foreign oils. American oils also contain less sulphur than foreign oils. Refining in the United States

[1]United States Public Health Reports, 1934, 49: 1101.

TABLE II.—OCCUPATIONAL GROUP II EXPOSED TO SUNLIGHT

1. A group with considerable exposure to sunlight and the elements

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Engineer, Civil | 5 | | |
| Farmer (54), gardener (2) | 56 | Farmer | 23 |
| Governess | 1 | | |
| Laborer | 42 | Laborer | 14 |
| Mail carrier | 3 | Mail carrier | 2 |
| Peddler | 2 | Peddler | 1 |
| Soldier | 2 | Soldier | 3 |
| | | Forest fire fighter | 1 |
| Total | 111 | Total | 44 |

2. A group with exposure to sunlight, the elements and to pitch and tar—group IV

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Fisherman | 2 | Fisherman | 2 |
| Diver | 1 | | |
| Dock worker | 1 | | |
| Sailors—Seaman, Marine and Navy Officers | 6 | | |
| Total | 10 | Total | 2 |

3. A group exposed to sunlight, trauma, and chemicals

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Bricklayer, cement worker and stone mason | 3 | Bricklayer | 2 |
| Carpenter | 11 | Carpenter | 10 |
| Painter | 4 | Painter | 7 |
| Total | 18 | Total | 19 |

Group II. Summary of Divisions 1, 2, and 3.

| | Cases | Cases | Total |
|---|---|---|---|
| Division 1. | | | |
| Carcinomas | 111 | .. | |
| Sarcomas | .. | 44 | 155 |
| Division 2. | | | |
| Carcinomas | 10 | .. | |
| Sarcomas | .. | 2 | 12 |
| Division 3. | | | |
| Carcinomas | 18 | .. | |
| Sarcomas | .. | 19 | 37 |
| | 139 | 65 | 204 |

is largely a closed process; the workmen have little contact with the oil. This probably accounts for one of the largest oil companies, employing thousands of workers and with records extending over many years, showing a surprisingly small number of cases of cancer of all parts of the body.

In occupational group II (Table II) it seems desirable to make three divisions, one a larger group, consisting largely of semiskilled and unskilled workers, whose occupations expose them much to sunlight and the elements.

The second division has a small number of cases. The occupations relate to the sea, the workers being exposed to sunlight and also to a known carciogenic agent, namely, pitch and tar of group IV. Schambaugh has increased our knowledge of this occupational hazard among seafaring people.

The third division of group II has only 3 occupations, skilled in character, presenting an almost equal number of carcinoma and sarcoma cases. Workers are exposed not only to sunlight but to chemicals, pitch and tar, asphalt, and oils.

With the exception of group VI, the miscellaneous group of occupations, group II has more than 2.8 times (the exact number is 204) the total number of cases found in all the other groups (groups I, III, IV, V, and VII have 71).

In occupational group II one is immediately struck by the large number of farmers and laborers with carcinomas, 98 in number. The sarcomas are slightly more than one-third the total carcinoma cases. Others in this country and abroad have noted the prevalence of cancer, particularly eyelid cancer, among farmers. Sunlight is considered an etiological factor in cutaneous cancer.

In the third division of group II several observers have noted that carpenters, bricklayers, and painters appeared to have an increased cancer incidence. English writers have found the distribution higher among carpenters than have American writers. Some have attributed this to frequent traumas. Our study does not bear this out. Only one case in our series gave a history of trauma. We believe that the occupational hazard is due to the handling of creosoted shingles, composition roofing which contains much tar and asphalt, and building papers and other lining products, many of which are chemically treated. Carpenters are subject to fine sawdust and particles from resinous compounds of lumber and composition building materials falling on the face and hands, which, in addition to the irritation of the sunlight, may be important etiological factors in the carcinoma group, but hardly, we think, in the sarcoma group.

There were 21 cases of carcinoma and sarcoma among the carpenters. Seven had basal cell tumors of the eyelids and 4 had squamous cell lesions of the lid and conjunctiva. More than half of these men were in the sixth and seventh decades of life or in the cancer age; the remainder were between 47 and 52 years of age. Of the 10 carpenters having a malignant melanoma, 7 tumors were in the choroid, 1 in the iris, and 2 in the conjunctiva.

Painters also have an increased cancer distribution. Chrome, which is a decided chemical irritant, frequently enters into the composition of paint and may be a possible etiological factor.

TABLE III.—OCCUPATIONAL GROUP III EXPOSED TO CHEMICALS

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| | | Chemist | 1 |
| Dye worker | 1 | | |
| Ice manufacturer | 1 | | |
| Ink manufacturer | 1 | | |
| | | Leather worker—tanner | 1 |
| Sulphur worker | 1 | | |
| Total | 4 | Total | 2 |

There has been difficulty in obtaining data from the south. Ophthalmologists of southern states comment upon the rarity of cancer of the eye. Hyde, in an extensive study of cutaneous cancer, noted fewer cases of cancer in the south.

Group III occupations involving a considerable use of chemicals (Table III) appear to have a very small cancer of the eye distribution. There are some 40 operations, mostly chemical, used in the process of tanning and preparing leather. Only one leather tanner worker was found. This patient had a melanosarcoma of the choroid, not due to his occupation. We have had no opportunity of visiting tanning factories or leather works. There have been a number of shoe factories in the surveyed areas but no records of neoplasms of the eye have been found in this occupational group.

Several industries use sulphuric acid which is commonly the cause of burns about the eyelids and conjunctiva. One case of cancer of the eyelid developed on a scar 5 years after a sulphuric acid burn.

Arsenic is a chemical which frequently produces malignancies of the skin. This study has not revealed any cancers of the eye among arsenic workers or arsenic users. The cancers due to arsenic are usually multiple in nature and are largely confined to the feet and hands. The face does not appear to be attacked. Only one author mentions a carcinoma of the eyelid due to arsenic. He observed 75 cancers due to arsenic among 38 persons.

Our survey material in group IV (Table IV) has drawn heavily in territories adjacent to the three large coal industrial areas of Pennsylvania, West Virginia, and southern Illinois. The records of eight institutions drawing patients from these coal areas revealed only 5 coal miners. Nowhere in the literature have we seen reference to an increased cancer incidence among coal miners.

On the other hand concentrated coal products, such as pitch and tar, derived by distillation of coal are potent carciogenic agents. According to 2 authorities, the use of tar in highway construction is a cancer hazard, not only to road workers, but to the entire population traveling the highways. We have found but 2 persons following an occupation to which this statement could apply; they were stone pavers.

TABLE IV.—OCCUPATIONAL GROUP IV EXPOSED TO (A) COAL, (B) PITCH AND TAR

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Coal miner | 4 | Coal miner | 1 |
| Fireman, stationary (a) | 1 | | |
| Official—coal company | 1 | | |
| Stone paver (b) | 2 | | |
| Total | 8 | Total | 1 |

TABLE V.—OCCUPATIONAL GROUP V EXPOSED TO RADIOACTIVE SUBSTANCES, RADIUM AND ROENTGEN-RAY

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Nurse | 2 | | 0 |
| Physician | 2 | | 0 |
| Total | 4 | Total | 0 |

Gas-house workers producing products derived from coal show a rather high cancer incidence in other parts of the body but not in the eye. We have made quite diligent inquiry concerning eye cases in this industry, but have failed to find any.

For many years a definite occupational hazard has been recognized in the handling and use of radioactive substances. Many of the lesions are of a squamous cell carcinoma type.

Four eye cases were collected, all of which were carcinomas (Table V). Three of these cases had other lesions than the eye lesions. One of the nurses had been treated years before for a lupus, which involved the cheeks. Protection had not been given to the eyes. The cancerous lesion was a squamous cell type involving the lower lid. The other nurse in our survey group had been a handler of radium for many years and developed a lymphatic leucemia. The other physician had a basal cell type of carcinoma which involved the face, eyelid, and forearm.

There are now about 150 cases on record of carcinomatous lesions developing in different parts of the body in workers long exposed to radioactive agents, such as roentgen-rays, and a smaller occupational group of radium workers who have developed osteogenic sarcomas and lymphatic leucemia. The radioactive occupational hazards to the eye and adnexa do not appear to be very great.

Nearly three-fourths of the 1,000 cases fall in group VI (Table VI). This group includes the more sedentary occupations, most of which are indoor occupations without much exposure to sunlight or to known cancer irritants. It includes

TABLE VI.—CONDENSED DISTRIBUTION OF 50 DIFFERENT OCCUPATIONS IN MISCELLANEOUS GROUP VI

Carcinomas

| Occupation | Cases |
|---|---|
| Clerical occupations | 4 |
| Domestic and personal service housewives (165) | 183 |
| Manufacturing and mechanical | 11 |
| Occupation none, retired, aged | 43 |
| Professions—clergymen (9), lawyers (2), teachers (7) | 18 |
| Public service | 5 |
| Students (8), child (1) | 9 |
| Transportation | 5 |
| Trades—business men (4), merchants (4), salesmen (7) | 20 |
| Unemployed | 20 |
| Total | 318 |

Sarcomas

| Occupation | Cases |
|---|---|
| Clerical occupations | 12 |
| Domestic and personal service housewives (181) | 194 |
| Manufacturing and mechanical | 21 |
| Occupation none, retired, aged | 77 |
| Professions—clergy (3), nurses (1), lawyers (2), teachers (3), physicians (4) | 16 |
| Public service | 4 |
| Students (22), child (17) | 39 |
| Transportation | 5 |
| Trades—business men (9), merchants (12), salesmen (15) | 36 |
| Unemployed | 3 |
| Total | 407 |

Grand Total 725

TABLE VII.—OCCUPATIONAL GROUP VII ENGAGED IN METAL INDUSTRIES

| Carcinomas | | Sarcomas | |
|---|---|---|---|
| Occupation | Cases | Occupation | Cases |
| Aluminum worker | 1 | | |
| Brass turner | 1 | | |
| Die engraver | 1 | | |
| Foundryman-molder | 2 | | |
| | | Gov't mint inspector | 1 |
| Grinder polisher | 1 | Grinder polisher | 1 |
| Iron worker | 3 | Iron worker | 1 |
| | | Sheet metal worker | 2 |
| | | Tin worker | 1 |
| Total | 9 | Total | 6 |

many semiskilled and unskilled occupations as well as some highly skilled occupations.

The number of females in this group is larger than in the other groups. A little more than one-third are classed as housewives on the records. It is difficult to explain this very large number in this group where no great occupational hazard is present.

Our data show an increased distribution of cancer of the eye among teachers and clergy. Several others have also noted an increase in these occupations which they were unable to explain on an occupational basis. These facts would indicate that in the majority of cancer cases there must be more constant etiological factors than occupational ones.

Table VI shows 89 more cases of sarcomas than carcinomas. The clerical occupations have three times as many cases. In the domestic and personal service occupations there were 11 more, and 16 more housewives than in the corresponding carcinoma group.

TABLE VIII.—SUMMARY OF ALL CASES IN ALL GROUPS

| | Carcinoma cases | Sarcoma cases | Total cases of both carcinoma and sarcoma | Percentage per 1,000 cases |
|---|---|---|---|---|
| Group I—Exposed to oils | 18 | 19 | 37 | 3.7 |
| Group II—Exposed to sunlight Div. 1, 2, 3 | 139 | 65 | 204 | 20.4 |
| Group III—Exposed to chemicals | 4 | 2 | 6 | .6 |
| Group IV—Exposed to coal, tar, pitch | 8 | 1 | 9 | .9 |
| Group V—Exposed to radioactive substances | 4 | 0 | 4 | .4 |
| Group VI—Miscellaneous occupations | 318 | 407 | 725 | 72.5 |
| Group VII—Exposed to metals | 9 | 6 | 15 | 1.5 |
| Totals | 500 | 500 | 1,000 | 100.0 |

The manufacturing and mechanical industries have double the number lacking one case. In the student and child group there are over four times as many as in the carcinoma group. The trades occupations, composed largely of business men, merchants, and sales people, have nearly double the carcinoma group. The group which has been designated as "occupation, none—retired and aged" has 34 more cases. The professional, public service, and transportation groups have nearly the same number of cases as the carcinoma group.

Among the unemployed there were almost seven times more carcinoma than sarcoma cases. This is accounted for by the much older age incidence of the patients.

In the survey of the metal occupations group, we find that most of the metal industries use one or more chemicals in connection with their products. In certain divisions of the iron industry sulphuric acid is used for bleaching in making gray iron castings. Workers are exposed to frequent splashes. Some of the cases gave a long history of exposure in their work. The tin worker had been employed by the same firm for 20 years. This occupational group is not large and has a little increased distribution of cancer of the eye as a whole (Table VII).

TABLE IX.—AVERAGE AGE, SEX, DURATION, AND HEREDITY DISTRIBUTION

| | Carcinomas 500 cases | Sarcomas 500 cases | Total number |
|---|---|---|---|
| Average age | 57.15 years | 48.5 years | |
| Females | 201 | 214 | 415 |
| Males | 299 | 286 | 585 |
| Excess of males | | | 170 |
| Heredity stated | 58 | 23 | 71 |
| No heredity | | | 380 |
| Heredity not recorded | | | 539 |
| Duration before seeking treatment | 493 cases 4.5 years | 467 cases 1.9 years | |

TABLE X.—ANATOMICAL DISTRIBUTION OF CANCER OF THE EYE

| Carcinomas | Cases | Sarcomas | Cases |
|---|---|---|---|
| Lower lid | 149 | Lower lid | 5 |
| Upper lid | 52 | Upper lid | 5 |
| Inner canthus | 90 | Inner canthus | 2 |
| Outer canthus | 32 | Outer canthus | 1 |
| Other locations about lids | 89 | Other locations about lids | 1 |
| Conjunctiva | 46 | Conjunctiva | 37 |
| Orbit | 42 | Orbit-primary | 50 |
| | | Lacrimal | 3 |
| | | Uvea: | |
| | | Choroid | 360 |
| | | Ciliary body | 13 |
| | | Iris | 23 |
| Total | 500 | Total | 500 |

### REVIEW OF GROUPS

Reviewing the occupational groups and the summary as given in Table VIII, four groups stand out as having an increased cancer of the eye distribution. However, not all the occupations in these groups show an increased distribution of cases above that found in the average general cancer rate per 1,000 cases.

Group I, occupations with exposure to oils and having relation to the automobile field, show an increased cancer distribution. Printers, plumbers, and steamfitters, who use oils more or less in their work, do not show any such increase.

Group II, occupations with exposure to sunlight, the elements, pitch and tar, and chemicals show a large increase. Especially to be noted are the large number of farmers and laborers who form 85 per cent of the 155 cases in this group.

Group VI, a large miscellaneous group having skilled, semiskilled, and unskilled occupations which are more or less sedentary in character and present no great occupational hazards, show a startling increase, particularly in the domestic and personal service occupations, 346, or more than a third of the entire 1,000 cases studied, being housewives.

The clerical occupations individually show no increase, but taken as a group they do show an increase. Likewise, the manufacturing and mechanical industries as a group show a considerable increase.

Group VII is a rather small select group of skilled artisans, mostly of the male sex. None of the nine occupations individually showed any increased cancer of the eye distribution, but the group as a whole showed an increase.

### OTHER POINTS OF INTEREST

There are many other points of interest in this occupational study of cancer of the eye, but only a few of the more important points can be briefly presented here, such as the age and sex distribution, the anatomical location of the lesion, the duration of the neoplasm before treatment was sought, and the heredity. Some of the records were incomplete in some of the details, particularly as relates to heredity (Table IX).

It has long been recognized that there is a distinct relation between age and the occurrence of epitheliomatous growths. In 320 cases obtained from the records of three institutions for the study and treatment of malignant disease, there were but 20 cases under the age of 40 years. Sarcoma cases average 10 years younger than carcinoma cases. Many of the occupations, such as janitor, watchman, laborer, retired, had a large number of aged persons. It appears that age rather than the occupation has to do with the larger incidence of cancer in many reports and also in some of our groups. The frequency of tumors in old age is well known.

The sex distribution shows a predominance of males over females, by 170 cases. Five of the seven occupational groups had occupations in which, as a rule, only men are engaged. Much of our material was drawn from large industrial centers which may possibly account for the predominance of men. The data on heredity are too incomplete to be of much value. Information on the duration of the symptoms before seeking treatment was difficult to obtain and is only about 70 per cent complete.

The anatomical distribution chart shows that carcinomatous lesions are confined largely to the adnexa and those parts most exposed to occupational irritants and traumas. A very different picture of the number and anatomical distribution of the sarcomatous lesions is seen (Table X).

The results of treatment, the pathological findings, and recurrence and metastasis data are reserved for future papers.

In closing there are two additional points learned in this study which, though not strictly having to do with occupations, I consider of suffi-

cient importance to bring to the attention of this body. One is, "Is cancer of the eye on the increase?" The other is, "Does influenza have anything to do with stimulating a cancerous growth?"

To the first question, "Is cancer of the eye on the increase," the answer is definitely "No." Survey of the records, year by year, over a period of 7 to 30 years, of the verified malignant tumors in the eye clinics visited, shows that the number of such tumors runs almost constant in every institution year after year. The retinoblastomas are remarkably constant, the average being 2 per year except in large clinics. The melanoblastomas average 5 to 6 per year except in two very large clinics where the average for several years has been 11 and 12 cases a year, respectively. The verified carcinomas of the eye and adnexa average 7 to 9 according to the size of the clinic.

The years immediately following influenza epidemics show a distinct rise in the number of sarcoma tumors. About three times the usual incidence is noted. This rise lasts about 2 years, then falls back to the level preceding the epidemic; often a few less cases will be noted for 1 or 2 years, then the rate goes on fairly constantly until the next epidemic, when an abrupt rise is seen again and the curve repeats itself. Unfortunately, only a few institutions have records going back to the early '90's when a large epidemic prevailed, and some institutions did not exist in 1918 when another large epidemic swept the country.

Many case reports gave a definite history of influenza, and not a few patients stated that they dated the beginning of the tumor from an attack of influenza, pneumonia, or a severe cold. Further information is now being gathered on this point, especially about the carcinomas, concerning which we do not have as full information as about the sarcomas. It is our desire that others interested in cancer in other parts of the body review their records and see if this observation can be confirmed. If it can, it strongly suggests that a virus or toxin may be an etiological factor in cancer.

I desire to thank the many institutions, ophthalmologists, and others who have contributed freely of their material for this study. A list follows.

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City Hospital, Cleveland
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Manhattan Eye, Ear, Nose and Throat Hospital
Knapp Memorial Eye Hospital, New York City
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Lighthouse Clinic, New York City
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Flower Hospital, Toledo
St. Vincent's Hospital, Toledo
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# THE CLASSIFICATION AND PROGNOSIS OF HODGKIN'S DISEASE AND ALLIED DISORDERS

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THE ideal classification of any group of diseases is an etiological one. We are ignorant, however, not only of the cause of Hodgkin's disease, lymphosarcoma, and allied conditions, but ignorant, indeed, of their very nature. Some diseases of unknown pathogenesis have a clear cut and characteristic clinical picture according to which they may be described and identified. Such is not the case with the group of disorders under consideration. For the time being, therefore, we must have recourse to a descriptive classification based upon the histopathological changes in the diseased organs. To be of practical value, such a classification must rest upon changes which can, in the majority of instances, be identified with reasonable certainty, and it must in some measure at least, be in accord with the clinical facts as we know them by experience.

The ideas presented to you today have been derived from a careful study of all those cases of Hodgkin's disease and allied disorders which have come under our observation, a total of 418 exclusive of the leucemias. By the use of the word "allied" we do not imply that the various pathological conditions to be discussed are necessarily related in their etiology nor, for that matter, in their pathogenesis. They are allied, if you will, merely because they appear to be diseases primarily in the lymphoid tissues of the body, allied in that their etiology is unknown, their nature obscure, and in that they present similar clinical pictures and have a similar clinical course.

No case has been included unless we have, at present, adequate pathological material of such character as to permit careful microscopic examination. A diagnosis based upon improperly fixed or stained material is impossible and we wish to stress this point strongly. Nowhere in the field of pathology is it of such paramount importance to have perfectly fixed and stained material.

Mallory, Ewing, and others in this country have classified tumors by dividing them according to the type cell from which they arise. We have followed their lead in the grouping of diseases under consideration, but it must be expressly stated that by so doing we make no implication as to the fundamental nature of the diseases in question.

There can be no doubt but that in the disease group under consideration there are several distinct and separate entities, but there is also no question but that clinically it may be difficult or impossible to distinguish one from the other. We have chosen, therefore, to group them all under one general heading, that of malignant lymphoma, a term deliberately vague and non-committal, malignant because they are almost invariably fatal, lymphomas because they involve, primarily, lymph nodes or lymphoid structures.

Under this general heading we recognize lymphocytoma, lymphosarcoma, reticulum cell sarcoma, early Hodgkin's disease, classical Hodgkin's disease, Hodgkin's sarcoma, and giant follicle lymphoma. Time does not permit a searching analysis of the histopathological characteristics of each type. They may, however, be briefly defined.

Lymphocytoma is a condition in which the involved lymph nodes are destroyed by adult lymphocytes without obvious invasion of the capsule or the surrounding tissues. It probably is always a peripheral manifestation of either lymphatic leucemia or lymphosarcoma.

In lymphosarcoma the lymph nodes are uniformly invaded by lymphocytes, mature or more rarely immature, and in addition, there is notable and often extensive invasion of the capsule with involvement of adjacent organs. As already indicated, it may be associated with or followed by lymphatic leucemia. Neither fibrosis nor eosinophilia occurs. Necrosis, if present, is of the infarct type. Lymphocytoma may be regarded as an initial stage of a process which progresses sooner or later to one of the more definitive forms. Indeed, the interrelation of these three conditions, lymphocytoma, lymphosarcoma, and lymphatic leucemia, is so intricate and so unpredictable that they may well be regarded, for practical purposes, as one and the same disease, arising in a disturbance of the lymphocyte or its progenitors and finding its expression in local, or more com-

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monly, widespread involvement of the lymphoid tissue throughout the body.

Such are the diseases traceable to the lymphocyte. Their pathological picture is clear cut, their diagnosis simple, their nature uncertain. They would appear to be quite distinct from the remaining forms of malignant lymphomas to be discussed. There do not seem to be transitional forms between the two great groups.

In reticulum cell sarcoma the involved organs and lymph nodes are invaded and destroyed by large, pale cells with vesicular nuclei which are round, oval, or more characteristically crescentic in shape. The cells, definitely larger than even immature lymphocytes, are actively ameboid and may be phagocytic. Nucleoli are not prominent and the chromatin is characteristically finely divided and widely spread. The cytoplasm is faintly acidophilic and of considerable amount. Multinucleated cells may rarely be seen, but they are definitely not of the Sternberg Reed type. Necrosis, when present, is of the infarct type. Eosinophils are not found. Fibrosis is rare. Invasiveness is common and often extreme. In its classical form the picture of reticulum cell sarcoma is definite and the diagnosis simple, yet atypical forms occur which tend to complicate, or perhaps to simplify, the problem.

Early Hodgkin's disease is an interesting and important condition. The involved lymph nodes, usually few in number and most often cervical, are invaded diffusely by mature lymphocytes, among which are scattered few or many typical Sternberg Reed cells. There is neither fibrosis nor eosinophilia. Superficially, the condition resembles rather a lymphocytoma than a true Hodgkin's granuloma. It is probable that many pathologists would fail to classify the condition in the Hodgkin's group, yet, both from its pathological picture and its subsequent transformation, it would seem to belong there without much question. The clinical course is usually slow. Indeed, the condition may remain entirely unaltered for as many as 20 years, yet, from a study of our cases with multiple biopsies, we believe that, in some instances, the condition gradually passes over into classical Hodgkin's disease, a condition which, with its Sternberg Reed cells, fibrosis, necrosis, and eosinophilic infiltration, needs no introduction nor elaboration here.

It may be argued that those cases of early Hodgkin's disease which fail to progress into the classical form are, indeed, an entirely different disease. But if this view be taken, it must be remembered that those which progress cannot, in their incipience, be distinguished from those which do not.

We now come to Hodgkin's sarcoma. Typically the involved tissues are replaced by large cells of uniform size surrounded by a considerable amount of deeply basophilic cytoplasm. The nuclei are round and characteristically present a very prominent nucleolus. Some cells are multinucleated, and there are scattered typical Sternberg Reed cells, without which a diagnosis cannot be made. The general appearance of the tissue is that of an embryoma or anaplastic carcinoma. Dead cells appear here and there, but there is neither fibrosis nor true necrosis. Neither polymorphonuclears nor eosinophiles are to be found. The disease runs a characteristically rapid course. Classical Hodgkin's disease may, at times, take on a sarcomatous nature and progress into this malignant form. Such a sequence of events has already been suggested by Ewing. Just as early Hodgkin's disease may unquestionably, with the passage of time, take on the full characteristics of classical Hodgkin's disease, so the latter may suddenly become highly malignant, and excised tissue will show areas indistinguishable from Hodgkin's sarcoma. We have fibroid phthisis, classical tuberculosis with cavity foundation, and miliary tuberculosis; so we have early Hodgkin's disease, classical Hodgkin's disease, and Hodgkin's sarcoma.

It would appear possible, therefore, though we are in no way prepared to assert it with assurance, that all these conditions are or may be interrelated, that early Hodgkin's and classical Hodgkin's diseases, reticulum cell sarcoma, and Hodgkin's sarcoma are but varying manifestations of the same disease, malignant and perhaps neoplastic tendencies being seen in the last two.

Giant follicle lymphoma is familar to all, the lymph node being studded in both cortex and medulla with large germinal centers, composed of uniform, pale, rapidly multiplying cells of uncertain origin. The absence of necrosis, polymorphonuclears, or phagocytosis serves to distinguish the condition from the purely inflammatory node. In our experience and that of others, this type of lymphoma always progresses into one of the other varieties, whether it be Hodgkin's disease, reticulum cell sarcoma, or lymphosarcoma. It is a relatively benign form of malignant lymphoma and is peculiarly radiosensitive, but the end is the same.

It should be pointed out that all diagnoses referred to here were made, so to speak, sight unseen without, that is, having recourse to the clinical history, except in so far as was necessary to rule in or out the presence of a leucemic blood picture. We have said that to be practical a classification must have at least a rough parallelism with the clinical history. From this point of view, let us

examine three points: age distribution, symptomatology, and prognosis.

The age distribution of lymphosarcoma shows a high peak in the second decade (27 per cent), a second peak in the fifties and sixties (26 per cent each). Virtually no case, in our small series, occurred in the first, third, fourth or fifth decade. If we group the early and classical Hodgkin's diseases together we find a surprisingly even age distribution. Roughly 14 per cent of all cases occur rather uniformly in each of the first seven decades. There is an insignificant rise in the third decade. The age distribution of the reticulum cell sarcoma group is quite different. Rare in the first decade, the incidence rises rapidly and steadily to a peak in the fifth decade, only to fall as rapidly again. A similar age distribution is found in the Hodgkin's sarcoma group—the incidence, in short, of malignant disease. The age distribution of the various types is therefore not haphazard, but in a sense, characteristic for each subdivision.

In a similar manner the initial symptomatology varies from group to group. The presence of a painless lump was the first symptom in 90 per cent of the early Hodgkin's disease cases, 80 per cent of the classical Hodgkin's disease, 55 per cent of the Hodgkin's sarcoma, 45 per cent of the reticulum cell sarcoma, and but 30 per cent of the lymphosarcoma cases. In contrast, an initial symptom of pain showed a precisely reciprocal relation: 5 per cent in early Hodgkin's disease, 12 per cent in classical Hodgkin's disease, 24 per cent in Hodgkin's sarcoma, and 45 per cent in reticulum cell sarcoma and lymphosarcoma.

So also does the prognosis of the various types differ. The average duration in the case of lymphosarcoma was 2.2 years; 83 per cent were dead within 3 years. No patient survived more than 10 years, but 17 per cent lived 3 to 10 years.

Similarly, the average duration of reticulum cell sarcoma was 1.8 years, and of this group 17 per cent lived into the 3 to 10 year period, yet 2 per cent were alive and free from recognizable disease from 10 to 15 years from onset. Reticulum cell sarcoma may be, in certain instances, an isolated lesion. Prompt and radical removal of the focus is the probable explanation of the survival of some cases. Thus of those cases of reticulum cell sarcoma being followed, 25 per cent had lived from 0 to 3 years from onset, 50 per cent from 3 to 10 years, and 25 per cent from 10 to 15 years. We wish to stress the fact that reticulum cell sarcoma may be an isolated lesion and that radical surgery has resulted in cures.

In Hodgkin's disease, we find the most interesting data as to prognosis. The average duration to death of the early Hodgkin's disease cases was 2.6 years, yet nearly 30 per cent survived 5 years or longer and nearly 20 per cent, 10 years and longer. Of those still alive, 20 per cent have had the disease 15 years or more; one case had it for 26 years. Classical Hodgkin's disease showed an average duration of 2.5 years. No patient lived more than 10 years; 68 per cent died within 3 years.

No individual with Hodgkin's sarcoma survived over 3 years The majority were dead within 1 year. This fact is entirely in accord with the neoplastic character of the condition.

It is difficult to give, with any degree of accuracy, the duration of the group embraced under the term giant follicle lymphoma, since this type probably always progresses into one of the others. Our figures show an average duration of 3.6 years.

## SUMMARY

It would appear from a study of the cases of malignant lymphoma at hand that a classification based upon cell morphology is possible in the vast majority of instances provided adequately prepared material can be had, and that this classification is practical and workable in that such clinical facts as age incidence, prognosis, and symptomatology are in accord with it.

Early Hodgkin's and classical Hodgkin's diseases are conditions rather evenly distributed throughout the decades. Hodgkin's sarcoma and reticulum cell sarcoma are primarily diseases of late adult life.

The initial symptomatology varies with the type of lymphoma. Painless lump is very common with early Hodgkin's disease, rare with lymphosarcoma; conversely, pain is common in lymphosarcoma and reticulum cell sarcoma, rare in classical Hodgkin's disease, very rare in early Hodgkin's disease.

The prognosis varies from group to group. No case of Hodgkin's sarcoma has been seen to survive the 3 year period. Classical Hodgkin's disease never survives the 10 year period. Not a few patients with early Hodgkin's disease live 10 years or more after their initial symptom. Lymphosarcoma rarely survives the 3 year period, never the 10. Reticulum cell sarcoma also rarely survives the 10 year period, but with appropriately radical measures, patients with this disease may live from 10 to 15 years; it is probable that true cures may result in certain instances.

An accurate pathological diagnosis of the specific type of malignant lymphoma is of very real value to the clinician.

# REPORT ON THE SECOND INTERNATIONAL CONGRESS OF SCIENTIFIC AND SOCIAL CAMPAIGN AGAINST CANCER

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SECOND International Congress of the Scientific and Social Campaign against Cancer, held in Brussels September 20–26, 1936, was well organized and carried through in a satisfactory manner. At the opening of the scientific meeting an address of welcome was made to the members of the Congress by Doctor Timbal, director general of the Ministry of Public Health, and by Mr. Justin Godart, president of the International Union against Cancer, which sponsored the Congress.

The scientific program was carried on in 6 sections and there were 6 official languages; German, English, Spanish, French, Italian, and Russian. The proceedings of the meeting will be published in these same languages. Much arduous work was done in all sections, and the personal contact of scientific workers, who have thus an opportunity to get easily acquainted with their colleagues' way of thinking, their temperament, their tendency to formulate conclusions quickly or prudently, enables one to appreciate certain facts which had been seldom pointed out in publications. It follows that there was absolutely no question of personalities.

In general, the quality of the papers was exceedingly high, and many interesting and important communications and reports were presented during the sessions. Only valuable communications received a hearing, as was evidenced by one paper that failed to receive recognition from the audience and chairman. The general exchange of opinions, although provocative and often heated, was always dignified. The particular interesting result from the Congress concerns certain reports of a scientific and social order which have enriched our knowledge in the field of cancer, while some had a position of only suggestive value.

Cancer investigations of the Congress, which seem to be attracting cancer research workers at the present time, as manifested by the proceedings lean principally toward a study of the carcinogenic agents, the factors of predisposition and of resistance to carcinogenesis, tumors transmissible with viruses, laboratory diagnosis, improvement in surgical and radiological treatment, chemotherapy, organotherapy, dietetic treatment, and the social campaign against cancer.

Dr. Kennaway, Dr. Cook, and collaborators of the Royal Cancer Hospital (Free) London, presented a communication entitled "Chemical Compounds as Carcinogenic Agents," and for this they received the award offered by the International Union against Cancer for the best work presented at the Brussels congress. A summary of the important features of this communication is as follows:

The various groups of carcinogenic chemical compounds were classified and discussed in the light of their chemical relationships, and their biological effects. The most active cancer producing compounds yet encountered belong to the cholanthrene group and are of special interest on account of their relationship to the bile acids. The carcinogenic properties of 3 : 4-benzopyrine, a constituent of coal tar, have now been extensively investigated, and the broad principles of molecular structure necessary for activity within the group of hydrocarbons and allied heterocyclic compounds related to 1 : 2-benzanthracene have been laid down. Results of interest have been described with water soluble carcinogenic agents, one of them being related to 1 : 2-benzanthracene, and another being a styryl quinoline of quite different structure. Weak carcinogenic activity has also been found in a number of hydrocarbons not related to benzanthracene. Recent work of Japanese investigators has shown that pathological effects (cholangioma, adenoma of the liver, hepatoma, and carcinoma of the bladder) can be produced by feeding experiments with relatively simple azo compounds.

Little progress has been made in elucidating the mechanism of cancer production by chemical compounds, but it is possible to enumerate a number of genetic and other factors which influence carcinogenesis. Many different media have been used for the administration of carcinogenic compounds, and control experiments with the media are important. Tumors have been produced by as little as 0.4y of 1 : 2 : 5 : 6-dibenzanthracene, and instances of the early appearance of tumors following the application of carcinogenic compounds are recorded. Cancer production by 5 compounds in a variety of tissues and species were summarized in a table and the rôle of estrin in tumor production was discussed in some detail. The various systemic effects of carcinogenic compounds were described and reference was made to the problem of lung tumors encountered in experimental work on carcinogenesis, to experiments on the transmission of chemically produced tumors by cell free materials, and to tissue culture.

Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

Another important paper on the same subject was by Dr. Lacassagne, of the Institut du Radium, Paris, who showed that with a series of chemical substances cancer of the breast was produced in male mice which otherwise never have cancer. This effect is presumably due in large part to the preservation of the mammary gland tissue which otherwise disappears in the male mouse, and not to a direct production of cancer by the hormone.

Many interesting and valuable communications and reports were given on the question of whether there are any factors of hereditary predisposition and of resistance to carcinogenesis underlying the appearance of cancer in animals. Among those reading papers on this complicated problem were: Nadine Dobrovolskaia-Zavadskaia, Dunning, Korteweg, Kreyberg, Miss Clara Lynch and Miss Maud Slye.

All of those competent in this field of endeavor felt that extremely important scientific communications were being made, but that the problems still contained many aspects which would have to be further studied from the experimental point of view before it would be of value in the study of human cancer.

Tumors transmissible by viruses were well presented by Dr. W. E. Gye, Imperial Cancer Research Fund, London. An exceedingly heated discussion followed between the author and Dr. J. W. Cook. The Congress was prudently reserved in its conclusions about the action of the cancerogenic virus, which must be made the subject of further investigations.

The diagnosis of cancer was the subject of many communications and reports. Serological diagnosis was given extensive study, and some very valuable reports were presented, but practical results do not always concur, and are not always satisfactory. No reaction is positive for all cancer bearers, nor is it specific of cancer, and no negative reaction is a proof of the non-existence of cancer. Their efficacy must be valued according to the maximum and minimum positivity figures in the cancer bearers and in the non-cancerous.

The problems of histological tumor diagnosis were well presented by Dr. James Ewing, of New York, and a summary of his report is as follows:

The main practical object of histological study of tumors is to establish the histogenesis. Unless the origin of the tumor is determined, the clinical significance of the case remains uncertain, whereas when the histogenesis is known, the clinician is able to predict the probable course of the disease, anticipate the usual extensions and complications, and direct treatment intelligently. The estimation of histological grades of malignancy should be attempted and may usually be determined by structural features. The majority of tumors fall within intermediate grades of malignancy, only about 10 to 15 per cent of the cases coming at the extremes, so that the determination of grade malignancy is of practical importance for treatment and prognosis only in the minority of cases. It must be emphasized that potential malignancy is only one of many factors determining the clinical course and outcome of the disease. In recent years many structural peculiarities of tumors have been found to be associated with striking peculiarities in the clinical course. A large part of refined tumor diagnosis involves the detection and evaluation of such structural features. This type of study is to be strongly recommended.

An important distinction is that between embryonal and anaplastic tumors. Strictly, embryonal tumors are believed to be comparatively uncommon. The habit of assuming an embryonal origin of many common tumors and of employing a nomenclature based on this assumed origin seems to be unwarranted.

The method of biopsy by aspiration through an 18 bore needle has proved of much practical value in experienced hands, especially in large cancer service, and is to be recommended.

Some current histological problems are briefly discussed. The occurrence of spindle cell carcinomas, especially epidermoid, is probably more frequent than is generally recognized. These tumors generally arise in lip, oropharynx, salivary glands, skin, and thyroid, and may be mistaken for sarcomas. The spindle character persists in metastases and the conditions of origin are undetermined. In the field of melanoma the main problem concerns the nature and behavior of the Langhans' cells in the malpighian layer of the skin. The writer accepts the origin of melanoma from peripheral nervous elements and feels that the existence of true malignant pigmented tumors of strictly squamous epithelial origin has not been satisfactorily proved. The exact conditions of origin of the common carcinomas of the testis are as yet undetermined. Endothelioma of bone the writer would derive from angioblastic cells connected with the blood vascular system of bone and bone marrow. Any relation to true bone marrow cells is rejected.

The main problem of the future for the tumor pathologist lies in the field of physiological interpretation of tumor structure. The recent contributions showing the influence of hormones, vitamins, and other physiological products in the production of tumors throws much light on the general significance and compels the tumor pathologist to undertake to trace the influence of these agents in the origin and behavior of these tumors. At present the field is marked by many pitfalls and uncertainties.

The rapidly expanding demands being made upon the tumor pathologist require more attention to the problem of organization of laboratory service. In order to acquire sufficient experience the tumor pathologist must rely on large collections of material, such as are available in various registries, which provide a very extensive material in accessible form. The general hospital seldom provides sufficient material to equip the general pathologist to interpret structure, and pursue essential problems. Tumor pathology should be recognized as a specialty, into which a general pathologist may well enter, but only after he has acquired a rather broad experience in general pathology.

Many communications were presented on the surgical treatment of human cancer. Dr. Henri Hartmann, president of the Academy of Medicine in Paris, presented a valuable communication, a summary of which is as follows:

The first part of the report comprises an account on electrosurgery (electric bistoury and electrocoagulation) which has played an important part in the treatment of various cancers, and which for some of them, has even superseded radium therapy. Then follows a study of the cancer of the lung, which, abandoned for some time, recently has been the subject of numerous works. As far as other cancers are concerned, the author limits his descriptions to the modifications recently applied in the technique of their resection and to operations which have, in the case of some cancers, resulted in an association of bistoury and other methods, the operation being started with applications of radium or with an electrocoagulation, thus giving an association of surgery—radiation or of surgery-electrocoagulation.

There were many valuable papers on the radiological treatment of human cancer, and a general discussion of the relative merits of low and high voltage x-ray treatment. On the whole, high voltage seemed to be most favored.

Dr. Francis Carter Wood stated that the biological aspects of roentgen-ray therapy were still in the rudimentary stage, and that there was little more knowledge today as to the mode of action on the cell than 10 years ago. Definite conclusions cannot be drawn as to the value of very high or very low voltage x-ray apparatus, and it would be unwise to construct more than a 1,000,000 volt machine until evidence had been obtained that its great cost was warranted. While there were many improvements in technique and equipment, as shown by the reports, it was generally agreed that progress was being made in both surgery and radiology, but no outstanding announcement of the same was made at the Congress.

There were many good papers on chemotherapy and organotherapy, with many claims for brilliant results, but those who are thoroughly conversant with these subjects feel that, while progress has been made, further investigation will be necessary before satisfactory results can be claimed. There must be taken into account the nature of the chemical or organic substances utilized in so far as dosage, frequency, and variations in the doses are concerned, under the permanent control of humors and excretions. These facts were well brought out by the communications of Hans Auler, of Berlin, and J. Maisin and Y. Pourbaix of the Institut du Cancer at Louvain.

Several papers on diet in cancer were presented, but nothing new was developed. Ernest Freund of Vienna presented one of the best reports relative to the dietetic treatment of cancer.

In spite of the influence of modern trends regarding therapeutics of cancer, which have not yet proved themselves, the Congress has not failed to insist upon the fact that we do not possess any curative remedies which can compete with surgery, x-rays and radium.

The social campaign against cancer was a very active session. Many valuable papers were presented, and some very warm discussions followed. All of these were of educational aspect, both for the laity and for the physician. The methods of organization of the cancer activities of the various countries, including not only Europe and North America but far distant countries, such as Australia, Brazil, Java, Japan, and New Zealand, were discussed by Doctor Lerat, president of the Congress, Marc Athias, René Sand, and many others.

The incurables were given attention through the paper presented by Dr. Le Bret, secretary of the French League against Cancer, Paris, which is summarized as follows:

Persons suffering from incurable cancer are not considered, in most countries, as patients, and are admitted only in a few establishments especially created for them.

This policy, which is absolutely unjustified, ought to be modified. Hospitals and refuges ought to accept, like any other patients, incurable cancer sufferers when they cannot find the required attention at home.

Anticancer centers and hospitals especially designed for the treatment of cancer must attend incurables, apply appropriate medical treatment, and provide for the required means of hospitalization.

The problem of medicosocial assistance to incurable cancer sufferers will thus be solved, but in order that this solution be practically achieved, it should enjoy the support of physicians, the good will of the hospital boards, and the assistance of the anticancer leagues.

One of the best papers of the section was presented by John J. Shaw, of Edinburgh. Burton T. Simpson of Buffalo gave the best paper on the function of the state in cancer control.

As the delegated representative of the College, I was extended many courtesies and privileges, and my reports on the Cancer Activities of the American College of Surgeons as well as the report on "The Incidence of Cancer among the Indians of the United States and Canada, with Specific Reference to Arizona," were well received. Investigations have shown that the death rate from cancer among Indians is materially lower than the death rate among other races residing in the United States and Canada.

The statistical sections listened to a number of excellent papers, two of special interest being by Mr. W. Cramer, of London, and Mr. Louis Dublin, of New York.

The meeting closed at noon on Saturday, September 26, with the ceremonies presided over by Dr. Lerat. The Third International Congress against Cancer, of which Dr. Francis Carter Wood

has been elected president, will be held in Atlantic City in 1939. The Fourth International Congress will be held in Budapest in 1942.

The following resolutions were read at the closing meeting:

1. It has been demonstrated in the course of the meetings that cancer, when treated in time, is very frequently curable, and that prophylaxis in certain forms of cancer is also possible.

2. Although in the present stage of our knowledge an effective systemic treatment of cancer is still unknown, the proceedings of the Congress have demonstrated the desirability of pursuing actively the search along these lines, as well as of the prophylaxis of cancer.

3. The Congress is confident that the International Union as well as the organizers of the next International Congress will do their utmost to combat quackery by all means in their power.

4. The statistical committee of the International Union is convinced that the study of accurate statistics will assist in throwing light on the etiology, diagnosis, treatment, and prophylaxis of cancer. The Congress appeals to public authorities, anticancer organizations, physicians, and insurance companies for their full co-operation in the establishment of such statistics.

5. The Congress is gratified to learn that the International Union has undertaken the publication of a diagnostic atlas of tumors.

6. The Congress expresses the wish that the training of nurses, midwives, and visiting nurses be directed in such a manner as to impress upon them the fundamental importance of the detection of cancer in its earliest stages, and the urgent importance of immediate treatment.

7. The Congress would also like to draw the attention of public authorities to the sad condition of incurable patients and to urge the provision of suitable hospital accommodation for them.

The resolutions of the social section, proposed as conclusions and read at the closing meeting, were as follows:

The section hopes that one of the aims of the International Union against Cancer will be the creation of a special committee, whose task would be to approach the respective governments and urge them to promote a national fight against cancer, and to collaborate closely with existing organizations. The Section feels that this endeavor, in order to be efficacious, should be adapted to the particular conditions of each nation, and hopes that the International Union will be able to draw up or suggest a general plan.

The Section considers that, in order to secure the accurate statistics required for the progress of science, and to provide all possible assistance for cancer patients under the best conditions, it will be desirable eventually to establish a confidential compulsory notification of cancer.

The Congress entrusts the International Union with the study of this problem, knowing that they will keep in mind the necessity of safeguarding as far as possible the susceptibilities of both patients and public opinion, and of maintaining the strictest guarantees of professional secrecy, both from medical and administrative points of view. It is hoped that the International Union will be able to present a report on this subject at the next International Congress which is to be held in 1939.

# THE RADICAL CURE OF CANCER OF THE PROSTATE

HUGH H. YOUNG, M.D., F.A.C.S., Baltimore, Maryland

IN 1905 we made an analysis of 318 consecutive cases of prostatic obstruction. We were amazed to find that there were 68 cases of cancer (21 per cent). The publication of these findings was followed by statistics from other clinics which confirmed our statement. Oliver Smith's statistics showed 16 per cent, Davis's 20 per cent, Moullin's 25 per cent, Kuemmell's 20 per cent, and Pauchet's 20 per cent. At the Institute of Pathology in Munich among 103 deaths from prostatic disease, 27 were found to be cancer. Wilson and McGrath, studying 468 prostatectomy specimens removed at the Mayo Clinic, found 73 cases of cancer (15.5 per cent). Freyer found among 1,276 specimens removed by suprapubic prostatectomy 171 cases of cancer (13.4 per cent). Microscopic examination was not carried out in all instances, so that the percentage of cancer is probably higher than stated. These statistics were sufficient to show that cancer of the prostate is a comparatively common disease, and a very important problem in surgery of the prostate. The very great frequency of the disease was not realized until recently when two startling articles concerning the percentage of cancer of the prostate which appeared in routine autopsies were published simultaneously by Rich and by Moore.

Rich reported as follows:

In 292 consecutive autopsies on males, 50 years or more of age, dying from a wide variety of causes on the medical, surgical and urological services of the Johns Hopkins Hospital during the past 3 years, frank carcinoma of the prostate was found in the routine microscopic section taken at autopsy in 41 cases (14 per cent). There is little doubt that a thorough search throughout each gland would have brought to light an even greater number of these tumors, many of which were so small that they were not seen macroscopically at the time of autopsy. The number discovered, however, indicates plainly enough that cancer of the prostate is considerably more frequent than is ordinarily supposed. In 65.8 per cent of these 41 cases the tumor was not recognized clinically, having been in most cases of a size too small to have produced symptoms, or to have attracted attention on physical examination. Of the 292 cases, 82 were from the urological service, and among these, 17 cases of cancer of the prostate were discovered (21 per cent). Twelve of these cases were diagnosed clinically; 5 not diagnosed. Of the patients between 55 and 60 years, 11 per cent showed cancer; between 66 and 70 years, 21 per cent; between 71 and 75 years, 28 per cent; between 76 and 80 years, 37 per cent; and between 81 and 90 years, 20 per cent.

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital.

Presented in the Cancer Symposium, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

Rich proved conclusively that there was no doubt that in each case he was dealing with a definite invasive carcinoma.

Moore stated that he found cancer in the prostate at autopsy in 21 per cent of patients over 41 years of age. His material was obtained from autopsies at two hospitals in Vienna in 1931 and 1932.

The gland was dissected free from the surrounding tissues and fixed uncut in 10 per cent formalin for 10 days or longer. After fixation blocks not over 4 millimeters in thickness were cut and paraffin sections, stained with hematoxylin and eosin, were prepared. The blocks were, routinely, coronal sections, but horizontal and sagittal sections were cut in some cases. . . . The entire prostate was cut into blocks and one microscopic section prepared from each block. The blocks were not subdivided unless they were larger than 5 by 3 centimeters. By this step section method (not serial section) all lesions larger than 4 millimeters in diameter could be studied microscopically. . . . In 52 patients under 41 years of age no carcinoma was found. . . . There were 252 patients between 41 and 90 years of age, and among them 51 cases of carcinoma were discovered (21 per cent). The details are given in Table I. In 52 cases the lesions were small and an accurate determination of the point of origin could not be determined. Fifty (73.7 per cent) arose in the posterior lobe, that portion of the gland posterior and posterolateral to the fan-shaped ducts which enter the sides of the urethra. Six (8.8 per cent) arose in the lateral lobes, that portion medial and anterior to these same ducts. Ten (14.8 per cent) arose in the anterior lobe, that portion which drains into the anterior furrow of the urethra. None has been observed in the middle lobe, that portion between the urethra and deferential canals and cephalad to the colliculus seminalis. . . . A study of the cases of carcinoma, which arose in a gland also the seat of benign enlargement, shows that the two disease processes are not related. In my first table the percentage of carcinomas in such glands is approximately the same as the occurrence of benign enlargement in the entire series.

It is evident therefore that Moore has come to the same conclusion which we reached in 1906, i.e., that carcinoma, in the large majority of cases, begins in the posterior subcapsular portion—"posterior lobe"—of the prostate, and is quite independent, for a long time, of hyperplasia of the lateral and median lobes, and that either may precede the other or both may develop concurrently and separately.

Moore says:

In these 52 cases just detailed, there is no clinical or gross pathological evidence of extraprostatic metastases.

Fig. 1. Cross section of prostate with adenomatous hypertrophy of lateral lobes which compress urethra; carcinoma of posterior lamella of prostate without invasion of lateral lobes; defect in posterior surface due to removal of tissue for biopsy. (B.U.I. Path. 8900.)

In 4 there is microscopic invasion of the seminal vesicle, in 3 by an apparent direct continuity of malignant disease, and in 1 with an area between the primary focus and the vesicles free of tumor. These 4 are the largest tumors of the 52. Observed from the viewpoint of the general problem of invasion and metastases, carcinoma of the prostate exhibits early invasion of the perineural lymphatics within the organ, but metastases and invasion outside the organ are a late manifestation of the disease.

In Moore's 52 cases of occult carcinoma, the gross diagnosis was made in only 10.

Moore concludes that carcinoma of the prostate occurs with increasing frequency until the ninth decade, when it reaches 29 per cent; that carcinoma is intimately associated with senile atrophy and is predominantly a lesion of the posterior lobe; that carcinoma and benign enlargement of the prostate are two distinct diseases which occur independently; that carcinoma rarely occurs in acini already hyperplastic and involved in benign enlargement.

TABLE I.—OCCURRENCE OF CARCINOMA AND BENIGN ENLARGEMENT IN 304 AUTOPSIES

| Age group | Prostates examined | Percentage which showed carcinoma | Percentage which showed benign enlargement | Percentage of carcinomas which arose in a prostate with benign enlargement | Percentage of benign enlargement which also showed carcinoma |
|---|---|---|---|---|---|
| 21 to 30 | 24 | 0 | 0 | 0 | 0 |
| 31 to 40 | 28 | 0 | 4 (1) | 0 | 0 |
| 41 to 50 | 23 | 17 (4) | 30 (7) | 25 | 14 |
| 51 to 60 | 65 | 14 (9) | 37 (24) | 50 | 21 |
| 61 to 70 | 77 | 23 (18) | 67 (52) | 66 | 23 |
| 71 to 80 | 63 | 21 (13) | 68 (43) | 46 | 14 |
| 81 to 90 | 24 | 29 (7) | 75 (18) | 71 | 27 |

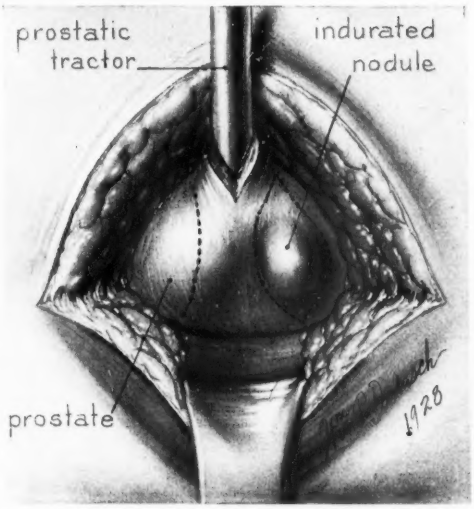


Fig. 2. Prostate exposed through perineum, and drawn downward by tractor introduced through membranous urethra into bladder. Indurated nodule in right lobe suspicious of cancer, excised (dotted lines) for frozen section and microscopic study; proved to be malignant. Hemiprostatectomy carried out. If it had proved to be benign, enucleating prostatectomy would have been done through bilateral capsular incisions. (B.U.I. 19552.)

The splendid pathological studies of Rich and of Moore, which have been cited above in detail, contain clinching evidence of the great frequency of carcinoma of the prostate, which in 1905 we stated to be present in 21 per cent of the patients presenting themselves on account of "prostatic obstruction." Their statistics indeed show that it is far more prevalent than suggested by us and furnish a powerful argument as to the importance of early and frequent rectal examinations to detect indurated areas in the prostate, and perineal exposure of the prostate when a positive diagnosis cannot be made by rectal examination alone.

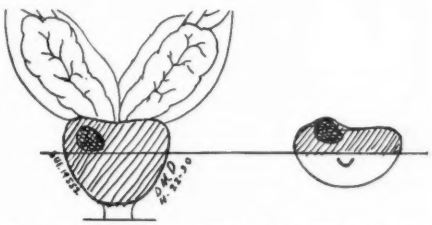

Fig. 3. Small carcinomatous lobule in left lobe, which is moderately elevated, of third degree induration. (B.U.I. 19552.)

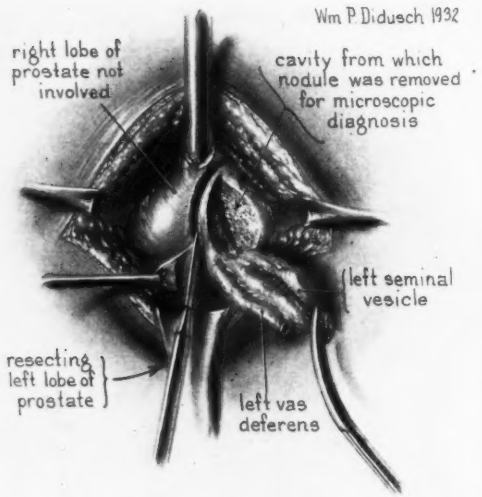
Wm P. Didusch 1932
right lobe of prostate not involved
cavity from which nodule was removed for microscopic diagnosis
left seminal vesicle
resecting left lobe of prostate
left vas deferens

Fig. 4. Hemisection of prostate being carried out after freeing seminal vesicle and dividing vas. (B.U.I. 19552.)

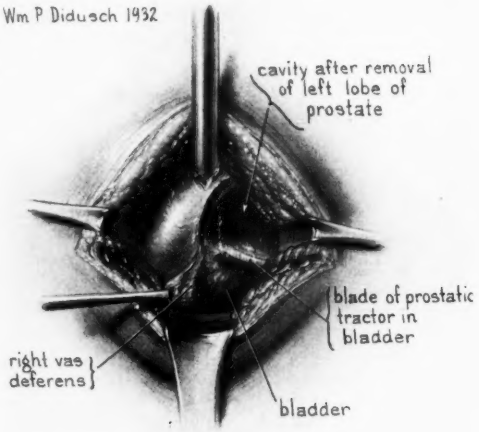
Wm P. Didusch 1932
cavity after removal of left lobe of prostate
blade of prostatic tractor in bladder
right vas deferens
bladder

Fig. 5. After removal of left lateral lobe, half of urethra, vesicle and vas. (B.U.I. 19552.)

### CLINICAL RECOGNITION OF EARLY CANCER OF THE PROSTATE

In one of our patients who came to Dr. L. F. Barker for a health survey, there were no symptoms of prostatic disease, but on routine examination of the prostate we found a nodule about the size of a very small pea beneath the capsule. This was of third degree induration, and imbedded in the posterior lobe. Cystoscopy showed no enlargement of the prostate, but on exposure through the perineum we found that the minute mass of induration was carcinoma, and obtained a complete cure by radical operation. In 2 other cases even smaller areas of carcinoma were found in tissue removed by prostatectomy through the perineum. Recognition of the malignant area was not made until careful microscopic study of the specimen. In other cases the carcinomatous nodule in the posterior portion of the prostate has varied from the size of a pea to that of a peanut or pecan. In most instances the prostate was quite smooth, the carcinoma had not infiltrated the capsule or Denonvillier's fascia, and the remainder of the prostate was uninvolved. The diagnosis was made on the third degree induration; at operation that fact was confirmed and radical cure was obtained. Prostatic charts of some of these cases are shown in Figures 3, 4, 18 and 26.

More extensive cases in which a large portion of the prostate was involved but the disease still remained well within the capsule and had not invaded either the membranous urethra below or the region of the vesicles above, are shown in the accompanying charts (Figs. 15 to 17, 20 to 24).

In many of these cases it was possible on exposure of the posterior surface of the prostate through the perineum to confirm the third degree induration and to carry out the radical operation without cutting into the tissues, but in a number of cases it seemed advisable to incise the nodule, and, in a few, to obtain frozen sections before the removal of the entire prostate and vesicles (Fig. 1). With the progress of time we have found that the ordinary method of preparing frozen sections is not satisfactory. Mistakes may be made unless a more prolonged technique and more satisfactory staining are obtained. This consumes about 15 minutes, but the increased accuracy justifies the delay. In one case an isolated nodule of tuberculosis was mistaken for cancer, and in a few cases extreme induration, associated with prostatitis, had been thought to be malignant.

To allow an early and radically curable case of cancer to go without operation is, we think, often inexcusable. In the recent literature numerous articles have appeared reporting hundreds of cases in which operation for prostatic obstruction has been carried out, and not a single case was subjected to radical operation for cancer. In view of the statistics of Rich and Moore and of the more extensive series of cases in which cancer was

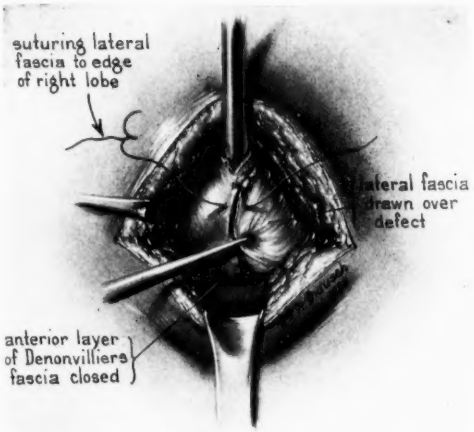
suturing lateral fascia to edge of right lobe
lateral fascia drawn over defect
anterior layer of Denonvilliers fascia closed

Fig. 6. Closure of defect with Denonvillier's fascia. (B.U.I. 19552.)

found at operation, it seems evident that many cases of cancer of the prostate which would have been curable by radical operation have been missed. It therefore seems justifiable again to impress upon the medical profession the great frequency of cancer of the prostate and the possibility of early diagnosis and cure.

The presence of hypertrophied lobes projecting well into the bladder and urethra does not exclude carcinoma, inasmuch as statistics show that, in 50 per cent of the cases in which cancer is present, benign adenoma of the median or lateral lobes is also present, and in many cases the growth is uninvolved by the carcinoma.

By the following facts we hope to show that by operation through the perineum, radical cures may be obtained, and this obtained in a large percentage of the cases in which the malignant invasion has not been too extensive.

### THE RADICAL OPERATION FOR CANCER OF THE PROSTATE

The details of the radical operation for cancer of the prostate, which we published first in 1905, have appeared in other papers. It seems unnecessary to give more than a brief description here.

The position of the patient is the same that we employ for all perineal operations. A special table affords a satisfactory exposure, but is not absolutely essential.

The curved incision in the perineal skin is a little longer than that for benign hypertrophy. The central tendon is exposed by blunt dissection and divided. Beneath it the recto-urethralis

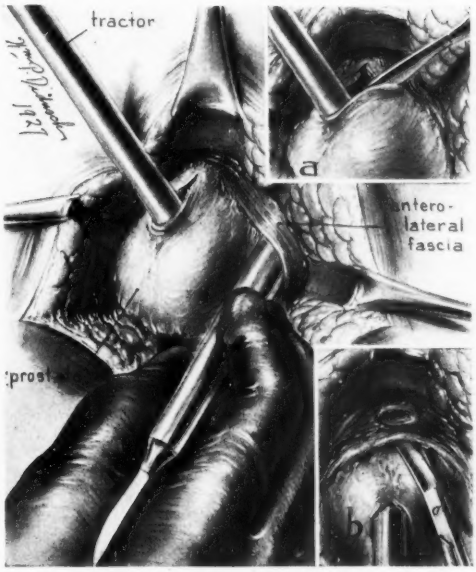


Fig. 7. Radical operation. Oblique view of prostate exposed after pushing anterolateral fascia backward. Urethra being divided in a; in b, anterior surface of prostate has been exposed by blunt dissection. Stump of membranous urethra is shown.

muscle is picked up, isolated, and divided, after which the membranous urethra may be exposed by drawing the sphincter downward, and incised well below the prostate (Fig. 2). The tractor is then introduced and opened out; the posterior surface of the prostate is exposed and carefully palpated to study the area of induration discovered on rectal examination. If this is very marked, or what is known as "third degree," one can usually make a diagnosis without cutting into it, but if there is any doubt, incision of the suspected area and inspection of the cut surface will often reveal the diagnostic yellow dots and lines. If doubt still persists, tissue may be removed and a frozen section prepared for careful microscopic study by one well versed in prostatic pathology. Having made certain that carcinoma is present, one should strip back the posterior layer of Denonvillier's fascia until the posterior surface of the seminal vesicles, covered by the anterior layer of Denonvillier's fascia, is exposed, palpated, and found apparently free from invasion. The absence of carcinomatous lymphatics and glands along the lateral wall of the pelvis should also be definitely confirmed before radical operation is undertaken.

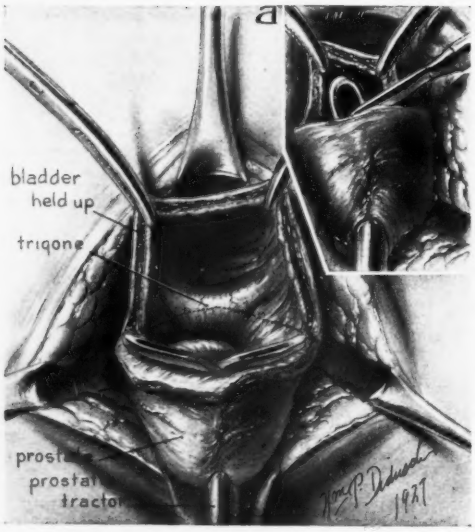


Fig. 8. Radical operation. Bladder well opened in front. Incision runs close to vesicoprostatic juncture. Trigone and ureters shown.

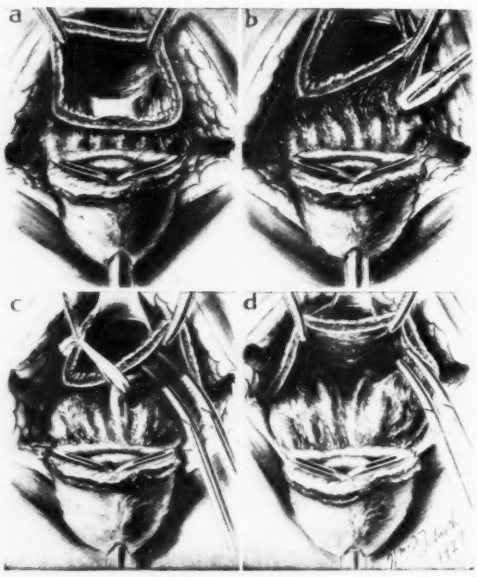


Fig. 10. a, Trigone divided, showing vesicles and vasa; b, bladder and ureters being pushed upward; c, ligation of left vas; d, pedicle and left vesicle clamped previous to division.

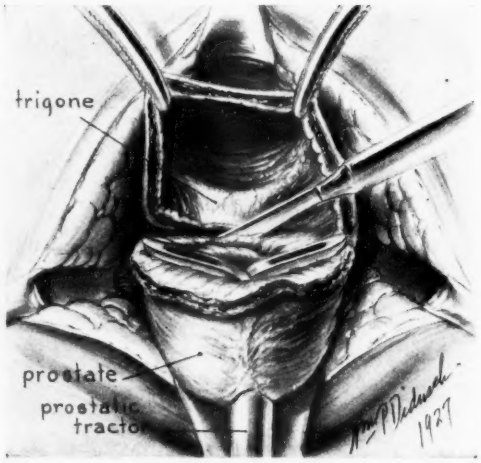


Fig. 9. Division of trigone 1 centimeter below ureteral orifices.

*Hemi-prostato-vesiculectomy.* When it is evident that the nodule is small and well confined within one lobe of the prostate, it may be sufficient to remove only one-half the prostate along with the seminal vesicle and ampulla. In this case (B.U.I. 19552) the nodule found on rectal examination (Fig. 3) was excised for diagnosis (Fig. 4). It appeared so isolated that we felt confident removal of only one-half the prostate along with the seminal vesicle and ampulla on that side would be sufficiently radical. The technique employed is shown in Figures 5 and 6. Our judgment has been justified in this case by the fact that the patient is alive and well, with normal micturition and normal sexual powers, 6 years after operation.

If physicians could be persuaded to include rectal examinations in all physical examinations of patients over 40 years of age, and to be suspicious of very marked induration, even of a small, very hard area in the prostate, the possibility of curing patients by hemi-prostato-vesiculectomy might occur more frequently.

*Total radical operation.* Having shown that the case is an appropriate one for total radical operation, the membranous urethra is divided in front of the tractor (Fig. 7) and the anterior surface is exposed by blunt dissection. If on palpation the disease is found not to invade the anterior portions of the prostate, one may safely go by blunt dissection beneath the transverse layer of the anterior pelvic fascia and thus avoid injury of the blood vessels and nerves which are so abundant in front and on the lateral aspects of the prostate

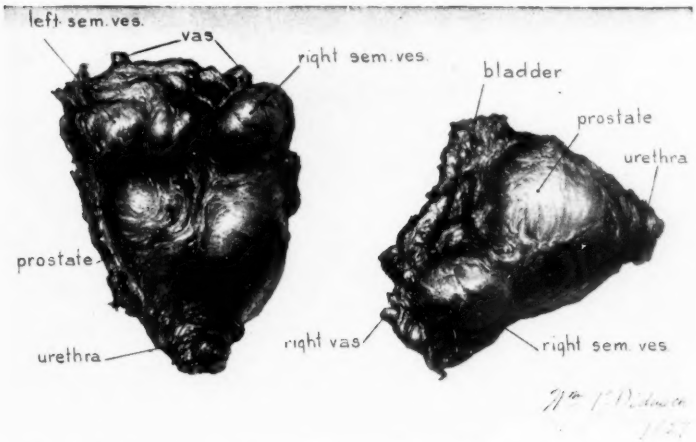


Fig. 11. Specimen removed in our first case, and comprising portion of membranous urethra, prostate with its capsule, a cuff of the bladder, large part of trigone, seminal vesicles, and vasa.

and bladder, thus obtaining postoperative urinary control. If, however, the anterior part of the prostate is invaded, it is wise to make the dissection more radical. Having isolated the anterior surface of the prostate, the operator next cuts into the bladder (Fig. 8) and then enlarges the wound on each side, thus exposing the trigone, the mucous membrane and muscle of which are divided fairly close to the lower ends of the ureters (Fig. 9), which are pushed upward with the bladder that has been completely severed from the prostate. The exposure of the vasa deferentia and seminal vesicles is shown in Figure 10. This removal should be as complete as possible, with intervening tissue preserved.

When the specimen is removed (Fig. 11) it comprises a portion of the membranous urethra, the entire prostate, completely encapsulated, and covered posteriorly with the anterior layer of Denonvillier's fascia, removed in one piece with the seminal vesicles, vasa deferentia, a cuff of the bladder, and a large portion of the trigone.

The defect, which appears large, is easily closed by approximation of the bladder and membranous urethra with chromic catgut (Fig. 12). The mucous membrane of the urethra and bladder is then approximated. The anastomosis is made around a catheter, which is kept in place about 10 days. The closure of the wound offers no difficulties (Fig. 13); no cases of persistent perineal fistula have been reported, and not a single case of stricture. This is probably due to the abundance of bladder wall employed in the anastomosis.

By careful attention to hemostasis, the shock is often less than that from an ordinary prostatectomy. In some cases it may be advisable to give intravenous glucose during the operation, and in very feeble subjects, a blood transfusion during or after operation.

*Extension of the radical operation to cases in which the rectum may be involved.* Whereas heretofore we have always avoided the radical operation whenever the carcinoma had penetrated the posterior capsule, we have had one case (B.U.I. 21226) in which this had occurred in only a small area. The rectum was adherent, and in order to obtain a radical cure, it was thought advisable to excise a portion of its anterior wall. This was performed without difficulty. In carrying out the radical operation in this case, after the membranous urethra was divided, and the anterior and lateral margins of the prostate freed, the bladder and trigone were incised, and the rectum was cut off well below the point of adhesion with the prostate. An area of mucosa about 4 by 3 centimeters in size was excised and removed with the specimen, after the seminal vesicles and vasa deferentia had been freed (Fig. 14). No difficulty was experienced by Harvey Stone in closing the defect in the rectal wall, and the anastomosis of the bladder to the membranous urethra was carried out as usual. On the forty-eighth day the patient unfortunately died from an acute attack of agranulocytosis. Examination showed no evidence of carcinoma. It seems probable that a radical cure would have been obtained.

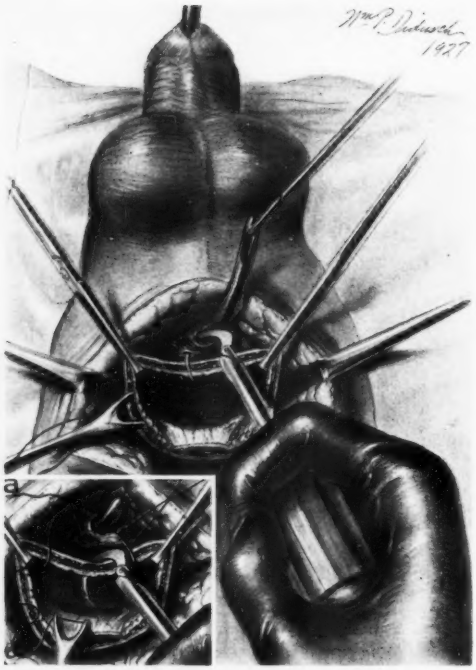


Fig. 12. Radical operation. Using boomerang needle holder, a chromic catgut suture is drawn through the roof of stump of the membranous urethra. In a, boomerang needle holder has come through the bladder to pull catgut suture through bladder wall where it is tied externally.

We believe, therefore, from our experience in this case that when the carcinoma has not progressed upward into the seminal vesicles or downward along the membranous urethra, and when only a small area of the rectal wall is invaded, a radical cure may yet be expected by the technique above described.

### POSTOPERATIVE CARE

The postoperative care is identical with that following other prostatic operations, and need not be stressed except to say that the use of large amounts of water by mouth, subcutaneously or intravenously in appropriate solutions, is indicated. If cardiovascular complications are present, the appropriate use of digitalis and other drugs is indicated.

### MORTALITY

Among the early cases the mortality was comparatively high, owing to technical mistakes. In 2 instances a ureter was mistakenly ligated in

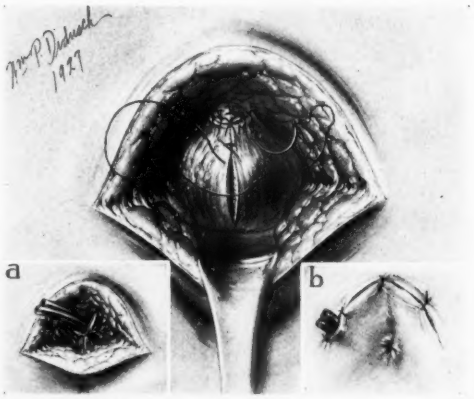


Fig. 13. Radical operation completed. Anastomosis between bladder and urethra, and remainder of wound almost completed. In a, the levators are approximated with plain catgut; in b, drainage of retroperitoneal space and closure of wound is shown.

closing the bladder defect. One patient died immediately following operation, and it was found that a generalized carcinomatosis of the peritoneum was present. In another case septicemia developed from a small peri-urethral abscess evidently produced by the inlying catheter.

The radical operation has been carried out in 61 cases. In 2 of these the final microscopic diagnosis was not carcinoma, although in 1 of these the biopsy at operation was reported to be cancer. A third patient had tuberculosis of the prostate, and in a fourth case a portion of the invaded rectum was removed. There were 7 hospital deaths among the 61 cases (11 per cent). If the case of tuberculosis and also that with rectal involvement be excluded, there are 5 hospital deaths among 59 cases (8 per cent).

There have been 26 consecutive cases without a death, and among the last 37 cases, there has been only 1 death (2.8 per cent). It is evident, therefore, that the radical operation itself is almost as free from danger as simple perineal prostatectomy.

### ULTIMATE RESULTS

After much effort we have succeeded, in 1936, in obtaining reports of the ultimate results 4 years or more after the patient left the hospital in all but 1 case:

1. Living and well over 5 years at last report, 7 cases: 22 years, 1 case; 12 years, 1; 11 years, 1; 10 years, 1; 9 years, 1; 8 years, 1; 6½ years, 1.

2. Died 5 years or more after leaving the hospital, and reported by their physicians to have

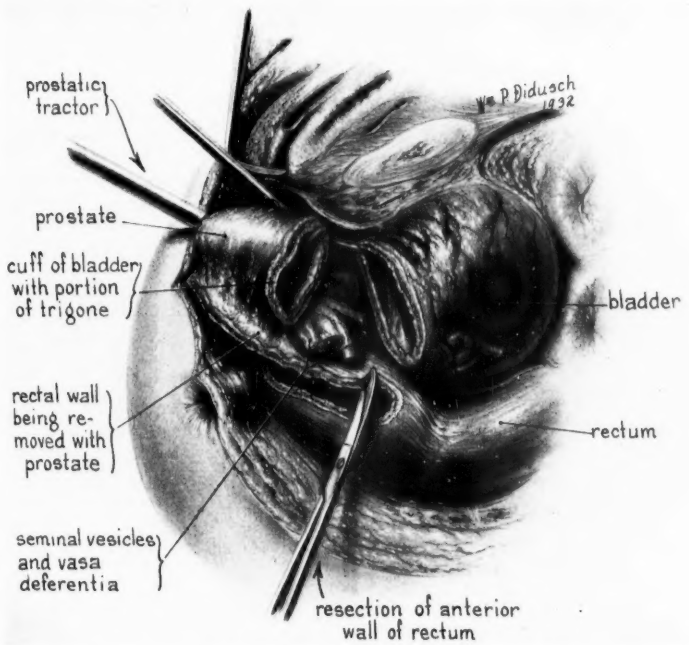


Fig. 14. Young's radical operation for carcinoma of prostate with excision of a portion of anterior wall of rectum involved. (B.U.I. 21226.)

had no recurrence or metastases, 9 cases: Interval: 15 years, 1 case; 9 years, 1; 8½ years, 1; 7 years, 2; 6½ years, 2; 6 years, 1; 5 years, 1.

One patient died less than 5 years after operation of another disease. A careful autopsy showed no recurrence or metastases.

We have, therefore, 17 cases (53 per cent) apparently cured. There are 4 patients who have died, but their physicians reported they were clinically well, viz., 1 died 2 years after operation from heart failure; 1 died 3½ years after operation from hypertension and apoplexy; 1 died 4 years after operation with no recurrence, cause of death not stated; 1 died 3½ years after operation from pneumonia. There are 2 patients operated upon more than 4 years ago, who report they are alive and well, with no recurrence or metastases.

Careful clinicians are reluctant to claim positive cures from operations for carcinoma. It seems evident that a good deal more than 50 per cent of our cases have shown no recurrence or metastases. The perineum is the only route by which the diagnosis of carcinoma of the prostate may be confirmed by inspection, incision, and biopsy, and if the disease is not too extensive, a radical cure is obtained probably in over 50 per cent of the favorable cases.

*Radical cure by partial prostatectomy.* Two cases, in which small nodules of cancer were completely removed in the course of perineal prostatectomy for supposed benign hypertrophy, and discovered on microscopic examination, have been cured. At the last report, 1 patient was living 11 years, and the other 10 years, after operation.

*Subtotal radical excision of carcinoma*, with partial removal of one or both vesicles, and conservation of both sphincters, has been carried out in 5 cases. Each of these patients has gone 5 years since operation without apparent recurrence or metastases.

*Percentage of cures.* If these statistics be combined, it is evident that considerably more than 50 per cent of the patients operated upon have been cured of cancer of the prostate. In this series there are a number of cases in which the disease had progressed upward beyond the limits of the prostate, and in some also below the prostate along the membranous urethra. If we eliminate these cases, in which the prognosis was manifestly unfavorable, the percentage of cures

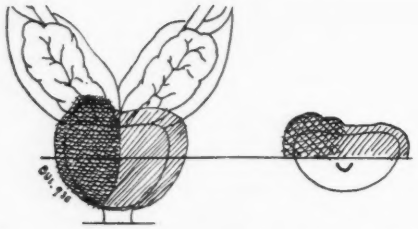

Fig. 15. Prostatic chart showing enlarged, markedly indurated left lobe (third degree) diagnosed carcinoma, invading left vesicle. Radical operation. No recurrence. Death 6½ years later from heart trouble. (B.U.I. 930.)

would be considerably increased, possibly to over 70 per cent, as I have previously stated, I believe with justification.

### CASES SHOWING POSSIBILITIES OF RADICAL OPERATION IN VARIED TYPES OF CARCINOMATOUS INVOLVEMENT

In order to show the possibilities of radical cure in varied types of carcinomatous involvement of the prostate, a series of successful cases is appended herewith.

CASE 1. (B.U.I. 930) J. E. D., aged 64, was admitted May 12, 1905, with obstruction to urination for 9 months; residual urine, 16 ounces. On rectal examination the left lobe of the prostate was very hard, with induration involving the lower portion of the vesicle; the right side was uninvolved (Fig. 15). Radical operation was performed with removal of prostate with neck of bladder, vesicles, and ampullæ; anastomosis of bladder to urethra. Microscopy showed carcinoma invading prostate, vesicles, and vasa. The patient died October 25, 1911, 6½ years after operation, from cardiac dilatation. Autopsy showed no cancer.

CASE 2. (B.U.I. 2166) L. A., aged 68, was admitted April 8, 1909, with frequent urination for 1 year. Rectal examination showed the right half of the prostate elevated, irregular, and markedly indurated (Fig. 16); the left half of the prostate and vesicles were negative. Radical operation and a biopsy showed carcinoma. Thirteen years after operation the patient reported that he was enjoying good health. He died in July, 1924, 15 years after operation, from senility.

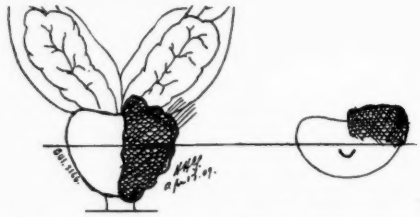

Fig. 16. Carcinoma of right lobe invading vesicle and portion of membranous urethra. Radical operation. Death 15 years later. No recurrence. (B.U.I. 2166.)

CASE 3. (B.U.I. 3659) G. R., aged 69, was admitted September 13, 1913, with dysuria and hematuria for 1 year. A large, very hard nodule projected from the upper surface of the left lobe of the prostate; the right lobe and vesicles were negative (Fig. 17). Radical operation and biopsy showed carcinoma. The patient died February 27, 1922, almost 9 years following operation. The physician reported no recurrence, and there was only slight incontinence during the day.

CASE 4. (B.U.I. 3913) E. G. B., aged 58, was admitted April 21, 1914, with frequency of urination for 2½ years. Rectal examination showed a moderately hard, smooth nodule of almost stony hardness in the upper half of the left lobe (Fig. 18), slight induration of the right lobe, normal vesicles and external adhesions. Radical operation and biopsy showed carcinoma. His last letter was dated February, 1936: "I am entirely well, with complete urinary control. I void at intervals of 4 hours during the day; hold urine all night." It is now 22 years since operation.

The following is an extensive case of carcinoma in which the radical operation was performed. The patient lived 7 years with a good functional result.

CASE 5. (B.U.I. 8234) P. A. W., aged 62, was admitted October 23, 1919, with urinary difficulty for 6 years, and great pain. Rectal examination showed a nodule of third degree induration in the lower right lobe (Fig. 19). The membranous urethra, the remainder of prostate and the vesicles were considerably indurated, but not of third degree. The prognosis was poor. Radical operation showed that the hard nodule had not penetrated the prostatic capsule; with miscroscopy adenocarcinoma was found. Examination July 19, 1924, showed recurrence, and x-ray examination disclosed metastasis to pelvis. October 21,

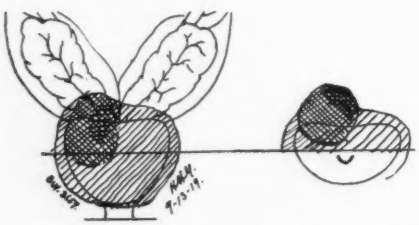

Fig. 17. Carcinoma of upper portion of left lobe. Radical operation. Death 9 years later. No recurrence. (B.U.I. 3659.)

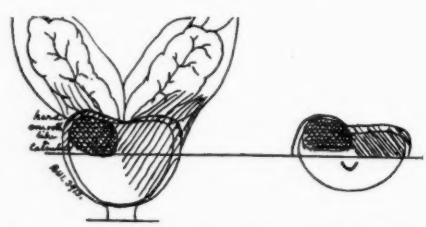

Fig. 18. Carcinoma of upper portion of left lobe. Radical operation. Well, 22 years after operation. Urinary control perfect; micturition normal. (B.U.I. 3913.)

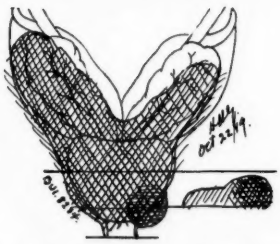

Fig. 19. Large carcinomatous nodule, lower end of right lobe, involving membranous urethra. Chronic vesiculitis and prostatitis. Radical operation. Patient lived 7 years in comfort. Death, metastasis to lungs. (B.U.I. 8234.)

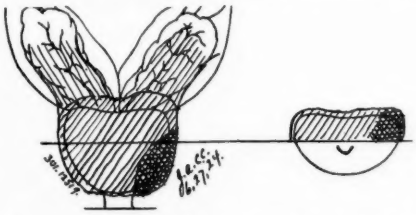

Fig. 21. Carcinoma of lower portion of right lobe. Radical operation (Dr. Colston). Reported well, 11½ years later. (B.U.I. 12519.)

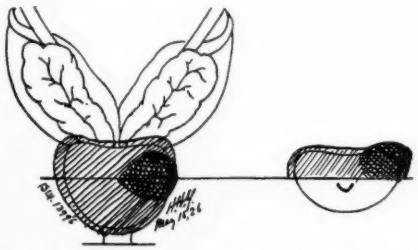

Fig. 23. Carcinoma of central portion of right lobe. Radical operation. Death, 6 years after operation, of right pyelonephritis. Physician reported no recurrence. (B.U.I. 13996.)

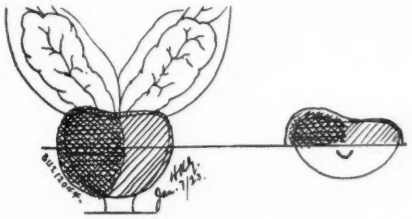

Fig. 20. Carcinoma of left half of prostate. Radical operation. Reported well, 12 years after operation (B.U.I. 12044.)

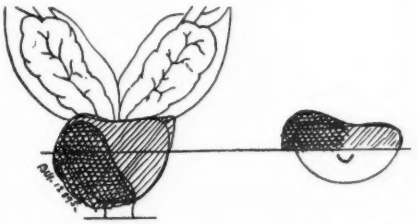

Fig. 22. Carcinoma of left lobe, apex of prostate, and portion of membranous urethra. Radical operation. Death, 4 years and 7 months after operation. Physician reported no evidence of recurrence. (B.U.I. 12895.)

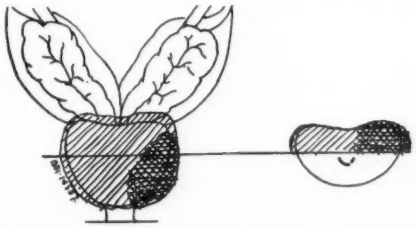

Fig. 24. Carcinoma of lower half of right lobe. Radical operation. Examination 10 years later showed no recurrence. Interval between urinations, 4 hours; no incontinence at night; occasionally slight in daytime. Patient states he has sexual intercourse about every 2 weeks. (B.U.I. 14557.)

1925 a letter stated: "It is now 5 years since operation. I void freely, without pain, at intervals of 2 hours, with good control, but pain in the back persists." November 12, 1925, x-ray examination showed metastasis to lung. Patient died 7 years after operation.

CASE 6. (B.U.I. 12044) S.Y.D., aged 60, was admitted January 12, 1924. He had no symptoms, but, during a medical survey, carcinoma of the prostate was suspected. On rectal examination the right lobe of the prostate was normal in size, smooth, and moderately indurated; the left lobe was slightly enlarged, indurated, and of third degree (Fig. 20). The membranous urethra and vesicles were negative. Radical operation and biopsy showed carcinoma. A letter (November 15, 1927) stated: "I am well; I have good control by night, and partly by day." In January, 1936, he wrote: "I am well." 12 years since operation.

CASE 7. (B.U.I. 12519) D. M., aged 51, was admitted June 27, 1924, with hematuria for 2 years and slight dysuria. The prostate was slightly broader and more prominent than normal, and very hard along the outer edge of the right lobe near the apex (Fig. 21). The vesicles were slightly indurated. The membranous urethra was negative. Radical operation was performed by Dr. Colston; microscopy showed carcinoma. Examination 3 years later showed no evidence of recurrence; urinary control was perfect and urination was normal. His brother reported in November, 1935, that the patient was entirely well (11½ years after operation).

CASE 8. (B.U.I. 12895.) J. E. W., aged 73, was admitted September 29, 1924, with difficulty of urination for 5 months. Prostate was normal everywhere except in the lower half of the left lobe in which there was an elevated,

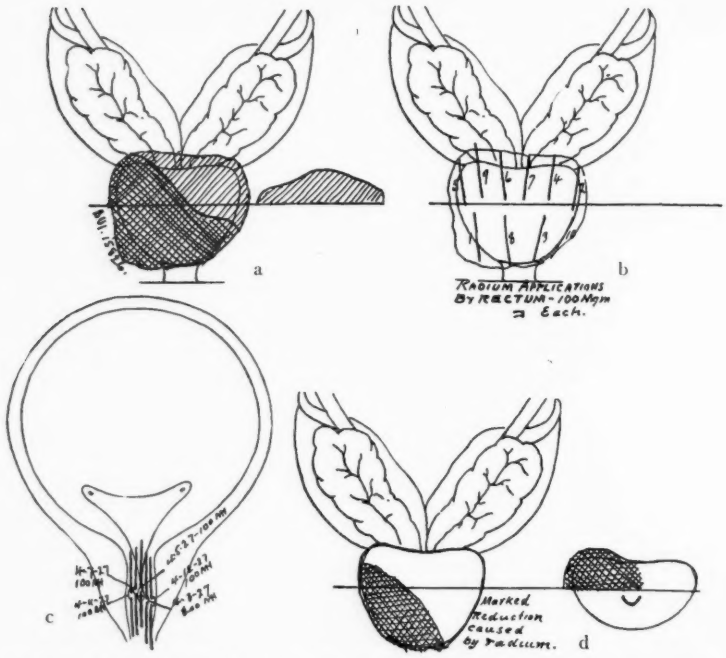


Fig. 25. a, Prostatic chart showing extensive carcinoma involving membranous urethra. It was thought best to give radium therapy. b, Chart of applications made to rectum; c, chart showing radium applications through urethra; d, showing marked reduction in size of prostate. Radical operation 3 months after admission. Patient reported well 9 years later. (B.U.I. 15826.)

smooth, extremely hard area 2.5 by 1.5 centimeters (Fig. 22). The vesicles and membranous urethra were negative. Radical operation was performed. Microscopy showed adenocarcinoma. November 16, 1927, his letter read: "Result of operation excellent; micturition normal; no incontinence. Now 3 years since operation." The patient died April 13, 1929, 4 years and 7 months after operation. There was no evidence of recurrence.

CASE 9. (B.U.I. 13996.) F. L., aged 68, was admitted October 8, 1925, with urgency of urination for 1 year. On rectal examination the prostate was found to be slightly larger than normal; a very hard nodule 1.5 centimeters in diameter was present in the right lobe (Fig. 23). The membranous urethra, the vesicles and ampullæ were negative. Radical operation was performed; microscopy showed adenocarcinoma. Examination February 4, 1928, showed no evidence of recurrence. A letter from Dr. A. J. Schwartman, Covington, Kentucky, reads as follows: "Patient was under my care until February 2, 1932, when he died (6 years after operation) of right pyelonephritis. There was no recurrence or metastasis."

CASE 10. (B.U.I. 14557.) Z. A. F., aged 61, was admitted March 17, 1926, with dysuria for 1 year. On rectal examination the prostate was found to be slightly enlarged, a hard, elevated area of third degree induration was found in the lower two-thirds of right lobe (Fig. 24). Radical operation was performed; microscopy showed adenocarcinoma. Examination March 24, 1936 (10 years after radical operation) showed a smooth cicatrix; no recurrence. "There is no incontinence at night; the interval during the daytime is 4 hours, occasionally there is slight leakage. The patient continues to have sexual intercourse about every 2 weeks."

Case 11 is an excellent example of what may be accomplished by very intensive radium treatment through the rectum and urethra before operation, thus making the radical operation possible.

CASE 11. (B.U.I. 15826.) L. R. T., aged 55, was admitted March 21, 1927, with dysuria for 2 months. Rectal examination disclosed the prostate enlarged and markedly indurated (Fig. 25). The surface was elevated and prominent, and induration was of the third degree, extending beyond the limits of the prostate with marked adhesions externally. The upper half of the right lobe and a part of the left were apparently uninvolved. The vesicles were negative. Diagnosis was carcinoma of the prostate, apparently too extensive for radical operation. X-ray examination was negative; there was no evidence of bony metastasis. Radium treatment was given with Young's rectal and urethral radium bearing sound containing in its beak two tubes of 100 milligrams of radium element. The patient received 1,000 milligram hours per rectum and 500 milligram hours per urethram (Fig. 25, b, c). He was dis-

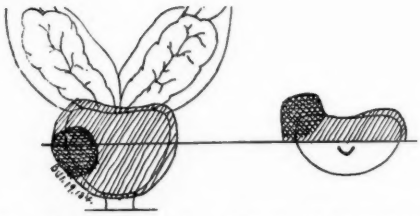

Fig. 26. Carcinoma of middle of left lobe. Radical operation. Letter from Dr. T. M. Davis 6½ years later stated patient was well, no recurrence, good urinary control. (B.U.I. 19185.)

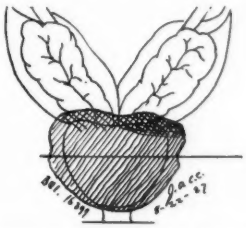

Fig. 27. Hypertrophy, prostatitis, carcinoma of upper portion. Radical operation. patient died 6½ years later from carbuncle. Wife reported operative result excellent, no recurrence. (B.U.I. 16399.)

charged April 13, 1927, much improved. May 9 ,1927, the rectal examination showed the area of third degree induration much reduced (Fig. 25, d). It occupied the lower third of the prostate and was apparently confined within the capsule. It seemed that the case was, then, a satisfactory one for the radical operation.

May 11, 1927, radical operation was performed; microscopy showed great destruction of tissue by radium, but that areas of carcinoma were still present. November 11, 1927, a letter stated: "Micturition free; no incontinence at night, only slight leakage in afternoon when fatigued." The patient's wife reported in March, 1936, that he was well, now 9 years since operation.

Case 12. (B.U.I. 19185.) J. H. W., aged 54, was admitted December 14, 1929, with slight urgency of urination for 3 years. Dr. T. M. Davis, Greenville, S. C., discovered a hard nodule in the prostate and referred the patient here. Projecting from the left lobe of the prostate was a very hard, smooth lobule (Fig. 26) which was of third degree. The remainder of the prostate was only slightly enlarged and indurated. The membranous urethra and seminal vesicles were negative. Radical operation was performed; microscopy showed carcinoma. March, 1936, a letter from Dr. T. M. Davis stated: "Patient is well; no evidence of recurrence. Relatives report he has urinary control" (now 7 years).

Case 13. (B.U.I. 16399.) G. T., aged 69, was admitted August 22, 1927, with difficulty of urination. On rectal examination the lateral lobes of the prostate were slightly irregular and firmer than normal, especially near the base of prostate (Fig. 27). The vesicles were irregular, but not thickened or indurated. Radical operation was performed by Dr. Colston; microscopy showed adenocarcinoma. The patient died February 25, 1936, 6½ years after operation, from a carbuncle. His wife reported that the result of the operation was good.

Case 14. (B.U.I. 17963.) J. T. G., aged 71, was admitted October 30, 1928, with symptoms of frequency and difficulty of urination for 4 years. On rectal examination (Fig. 28) the prostate was moderately enlarged. The right lobe was prominent, smooth, and very hard (third degree). The vesicles and membranous urethra were negative. Radical operation was performed; microscopy showed adenocarcinoma. Perineal leakage ceased the third week. The patient was discharged the fifth week and was voiding without difficulty. October 30, 1936, a letter stated: "There is no evidence of metastasis or recurrence; it is now 8 years since operation."

Case 15. (B.U.I. 21486.) J. M. F., aged 72, was admitted April 18, 1932, with nocturia for 2 years, but no increased frequency by day. For 2 weeks there had been a bearing down sensation in the rectum. On rectal examination there was a very hard, round nodule in the right lobe (Fig. 29). The remainder of the prostate was slightly enlarged and indurated. The vesicles and membranous urethra were not invaded. Radical operation was performed; microscopy showed adenocarcinoma. The patient was discharged the twenty-fourth day after operation. February 13, 1936, the date of the last report, the patient stated that he voided urine 5 times during the day, once at night, and that there was no pain. There has been no evidence of recurrence or metastasis, now almost 4 years since operation.

Case 16. (B.U.I. 21431.) F. C. G., aged 72, was admitted March 31, 1932, complaining of marked difficulty and frequency for 2 years. Rectal examination showed the left lobe hard, irregular, and prominent (third degree induration); the right was only slightly indurated and enlarged (Fig. 30). Radical operation was performed; microscopy showed carcinoma of the prostate. The last report (March 5, 1936) indicated that the patient was well, with no evidence of recurrence or metastasis, now almost 4 years since operation.

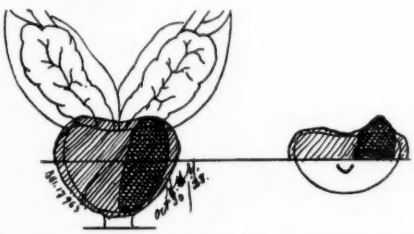

Fig. 28. Carcinoma of left lobe of prostate. Radical operation. Patient reported well 8 years later. (B.U.I. 17963.)

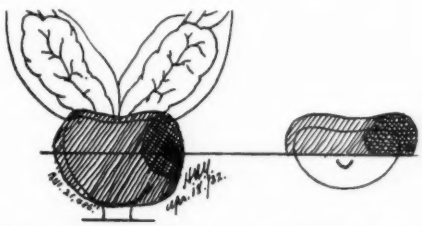

Fig. 29. Carcinoma of right lobe of prostate. Radical operation. Report 4 years later, no evidence of recurrence or metastases. (B.U.I. 21486.)

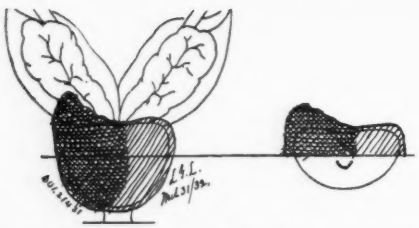

Fig. 30. Carcinoma of left lobe of prostate involving part of vesicle. Radical operation Patient reported 4 years later free from recurrence condition excellent. (B.U.I. 21431.)

RÉSUMÉ

Recent statistics show that cancer of the prostate occurs in at least 14 per cent of the men past 44 years of age. Cancer of the prostate is three times as common as that of any other internal organ in man. One-half the cases of cancer of the prostate are associated with prostatic hypertrophy. The two lesions are distinct in their origin. In a large percentage of the cases, cancer begins in the posterior lobe, where it is easily palpable by rectum. An area of very marked induration (third degree) should be viewed with suspicion. A positive diagnosis can be made without danger by exposure through the perineum.

If the cancerous nodule is very small, it may be radically removed by hemi-prostato-vesiculectomy. If more extensive, the radical operation here described has been shown to result in a complete cure in over 50 per cent of the patients operated upon. If physicians could be aroused and persuaded to make rectal examinations during all physical examinations on men past 40 years of age, many early cases would be discovered.

The medical literature has been filled in recent years with a long series of cases in which patients were treated by prostatic resection, but not a single attempt was made to cure cancer by radical operation. It is evident that the operators have either failed to recognize carcinoma of the prostate sufficiently early, or have denied these patients the chance of being cured.

The radical operation is not difficult; the mortality is low. Normal micturition and complete urinary control have been obtained in many cases. In those cases in which the patients were not cured, but died later of metastasis, the local result was often good.

The perineal route furnishes the only adequate approach for confirmation of the diagnosis of cancer of the prostate and its radical cure. In benign cases it furnishes better results and the mortality is as low as for any other procedure, I believe, if the patient is followed for a month.

# TREATMENT OF GIANT CELL TUMORS ABOUT KNEE

## A Study of 153 Cases Collected by the Registry of Bone Sarcoma of the American College of Surgeons

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ALTHOUGH few of them will realize it, all future patients with giant cell tumors should feel grateful to four American doctors who have made distinctive contributions to our methods of treatment of this type of bone lesion. Two of the four were Philadelphians. Until 1879, when Samuel W. Gross of Philadelphia wrote his classic paper on bone tumors, all forms of sarcoma were considered malignant and amputation was recommended in all cases of tumors of the bones forming the knee. Gross definitely showed the relatively favorable prognosis of the central giant cell form but still recommended prompt removal of the limb, except in cases in which the tumor was in a position from which it could be completely resected. This was just prior to the advent of asepsis, and it is noteworthy that he recommended amputation, although he states that the immediate operative mortality was then 31 per cent. This shows that he considered the prognosis of this variety almost hopeless without operation, although better after amputation than that in other forms of sarcoma.

Coley's unremitting interest in these tumors began in 1892 and lasted until his death in 1936. His enthusiasm for his toxins led him to follow his cases carefully, and to interest the whole profession by his annual statements about his results. Although he used toxins, he followed Gross's opinion and continued to amputate for tumors about the knee. If the patients survived, he found that the tumors were usually of the giant cell type. When Bloodgood (1902) stated his conviction that amputation was unnecessary in the giant cell type and that the cases might be cured by curetting, Coley soon appreciated Bloodgood's point and began to curette instead of amputate. He continued to have good results but still attributed this fact largely to the use of the toxins.

In 1907 Pfahler, the Philadelphia roentgenologist, made another important contribution and showed that these tumors could be treated by roentgen-rays without recourse to any surgical operation and that the patients might survive for many years, since the tumors remained as quiescent bony enlargements. Pfahler has also demonstrated that malignant changes may occur in such cases even after they have been "5 year cures."

When the registry of bone sarcoma was started in 1920, I think it is fair to say that most surgeons were still amputating for all forms of sarcoma at the knee, including the giant cell type, although a few had taken Bloodgood's advice and had tried curetting as a primary operation. Coley was amputating or curetting according to his surgical judgment and, in addition, he was employing his toxins and often radiation as well. Pfahler's recommendation of using radiation alone was soon supported by Ewing, Herendeen, and a few others, who, in a series of cases, used it as a primary treatment and refrained from surgery except for biopsy. Then the registry committee, at first consisting of Bloodgood, Ewing, and the writer, began to collect individual cases, to record their diagnoses on examination of all available data, and to wait for the future to correct their errors.

Now that 16 years have elapsed, it seems worth while to review the registered cases of giant cell tumor in the bones about the knee. Obviously this is a difficult region on account of the mechanical strains incident to normal use of the lower limb. If we can find any general principles from the study of the tumors in this location, it is likely that the same principles will govern our treatment of such tumors in other bones.

One hundred and fifty-three cases, listed in the Registry as giant cell tumors, have been studied and tabulated in regard to the results of various forms of treatment. Over 100 of these cases had been followed for more than 5 years and over 50 for more than 10 since the onset of first symptoms. Twelve other cases are mentioned in the text because their films resembled those of giant cell tumors, although biopsy had shown that they were instances of other lesions essentially malignant. It is important to understand that these 12 were selected from over 600 malignant cases,

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TABLE I.—AMPUTATIONS—44 CASES

| Treatment | Registry number | Registered by | Years traced from onset |
|---|---|---|---|
| | | A, Femur | |
| Ⓐ | 41 | J.A.Mattison | 14 |
| Ⓐ | 51 | A.Schwyzer | 39 |
| Ⓐ | 103 | J.C.Bloodgood | 20 |
| Ⓐ | 105 | J.C.Bloodgood | 13 |
| Ⓐ | 306 | L.A.Shoudy | 17 |
| Ⓐ | 454 | Presbyterian, N.Y. | 16 |
| Ⓐ | 580 | Presbyterian, N.Y. | 11 |
| Ⓐ | 1008 | G.W.Van Gorder | 8 |
| Ⓐ | 1011 | G.W.Van Gorder | 7 |
| Ⓐ | 1287 | G.S.Johnson | 8 |
| Ⓐ | 1416 | Loucks and Shih, Peiping | −5 |
| Ⓐ | 1556 | Miltner and Chang, Peiping | 8 |
| Ⓑ | 60 | W.G.Stern | 13 |
| Ⓑ | 149 | H.Newhall | 16 |
| Ⓑ | 503 | R.A.Hanna | 5 |
| Ⓒ | 528 | W.A.Evans | 6 |
| Ⓒ | 819 | W.M.Mills | 9 |
| Ⓒ | 822 | Massachusetts Memorial Hospital | 12 |
| Ⓒ | 858 | W.B.Coley | 11 |
| Ⓒ | 1408 | Loucks and Shih | 7 |
| Ⓓ | 38 | R.D.McClure | 11 |
| Ⓓ | 321 | Memorial Hospital N.Y. | 15 |
| Ⓓ | 358 | Memorial Hospital N.Y. | 15 |
| Ⓓ | 954 | A.E.Strachauer (after resection) | 11 |
| Ⓔ | 387 | Memorial Hospital N.Y. | 15 |
| Ⓕ | 646 | B.L.Coley | 12 |
| Ⓖ | 388 | W.B.Coley | 8 |
| | | B, Tibia | |
| Ⓐ | 48 | Massachusetts Memorial Hospital | −5 |
| Ⓐ | 88 | C.C.Simmons | 9 |
| Ⓐ | 205 | C.N.Dowd | 18 |
| Ⓐ | 708 | Massachusetts Memorial Hospital | 6 |
| Ⓐ | 874 | L.S.Booker | 11 |
| Ⓐ | *896 | J.C.Bloodgood (left) | 15 |
| Ⓐ | 982 | J.M.Troutt | 16 |
| Ⓐ | 1325 | Hugh Jeter | 5 |
| Ⓑ | 89 | C.C.Simmons | 14 |
| Ⓒ | 320 | B.L.Coley | 14 |
| Ⓘ | 1782 | Willis C.Campbell | 5 |
| Ⓔ | 7 | J.J.Buchanan | 19 |
| Ⓕ | 144 | W.B.Coley | 14 |
| Ⓓ | 1579 | E.I.Bartlett | 6 |
| Ⓙ | 1615 | C.C.Simmons | −5 |
| Ⓓ | 1729 | M.J.Schlesinger | −5 |
| | | C, Fibula | |
| Ⓐ | 1419 | Loucks and Shih | 11 |

There are other cases in the Registry series, besides those tabulated above, which are carried under the diagnosis of giant cell tumor and have survived at least 5 years from onset of symptoms, but have been omitted from Table I for the following reasons:

1. Because I think they should more properly be classed as solitary bone cysts, and since bone cysts have a very different natural history from giant cell tumors they should not be statistically confused. True giant cell tumors rarely occur before 15; any central tumor below the epiphyseal line is likely to be a cyst.

Omitted for this reason: 87 traced 5 yrs.; 142, 9 yrs.; 428, 5 yrs.; 882, 8 yrs.; 1246, 19 yrs.

2. Because the roentgenogram and slide suggest the variant which I have described as epiphyseal chondromatous giant cell tumor. These are usually aged 10 to 20. Since the table is intended to include only cases in which the x-ray gave typical appearances of giant cell tumor, these cases are omitted. Their x-ray characteristics are much more like the appearances presented in osteogenic sarcoma.

Omitted for this reason: 905 traced 9 yrs.; 1391, 6 yrs.; 1628, 6 yrs.; 1698, 6 yrs.; 1728, 5 yrs.

3. The following 30 cases were omitted because they were traced less than 5 years although all of them were successfully treated as far as is known. They are here listed because their numbers may be used by anyone who chooses to repeat the study in later years when these cases have run a longer course: 20, 110, 238, 257, 281, 290, 395, 405, 440, 494, 518, 769, 797, 824, 845, 895, 925, 1086, 1327, 1409, 1415, 1501, 1519, 1529, 1544, 1553, 1598, 1632, 1634, 1648.

The 14 cases which became malignant are not included in the table but would bring the total studied to 154. It would be unfair to say that 14/153 became malignant for in most of the 14 the original slide was not available.

TABLE II.—NOT AMPUTATED—47 CASES

| Treatment | Registry number | Registered by | Years traced from onset |
|---|---|---|---|
| | | A, Femur | |
| Ⓚ | 34 | F.Kammerer | 6 |
| Ⓚ | 221 | J.S.Stone | 15 |
| Ⓚ | 328 | G.W.Morse | 15 |
| Ⓚ | 771 | E.M.Miller | 21 |
| Ⓚ | 828 | J.W.Lindsay | 8 |
| Ⓚ | 1041 | E.W.Hanrahan,Jr. | 5 |
| Ⓚ | 1539 | B.L.Coley | 8 |
| Ⓛ | 717 | W.M.Brickner | 16 |
| Ⓛ | 870 | G.W.Forman | 9 |
| Ⓛ | 1085 | C.C.Simmons | 9 |
| Ⓛ | 1779 | E.L.Bishop | 12 |
| Ⓛ | 204 | U.S.Kann | 16 |
| Ⓜ | 15 | J.B.Deaver | 9 |
| Ⓜ | 33 | F.Kammerer | −5 |
| Ⓜ | 182 | W.B.Coley | 16 |
| Ⓜ | 381 | Memorial Hospital N.Y. | 11 |
| Ⓜ | 520 | J.F.O'Brien | 12 |
| Ⓜ | 529 | W.A.Evans | 8 |
| Ⓜ | 659 | G.S.Dudley | 13 |
| Ⓜ | 1305 | B.L.Coley | 8 |
| Ⓜ | 1339 | D.B.Phemister | −5 |
| Ⓜ | 1527 | R.E.Herendeen | 15 |
| Ⓝ | 170 | J.Ewing | 9 |
| Ⓝ | *896 | W.B.Coley (right) | 8 |
| Ⓞ | 847 | L.C.Abbott | 9 |
| Ⓟ | 180 | W.B.Coley | 21 |
| Ⓠ | 27 | C.E.Harris | 20 |
| | | B, Tibia | |
| Ⓚ | 259 | J.E.Thompson | −5 |
| Ⓚ | 464 | Maj. S.F.Coupal | 13 |
| Ⓚ | 788 | W.B.Coley | −5 |
| Ⓚ | 977 | H.B.Thomas | 6 |
| Ⓚ | 1176 | C.C.Simmons | 6 |
| Ⓚ | 1295 | B.L.Coley | 6 |
| Ⓛ | 402 | M.B.Palmer | 7 |
| Ⓛ | 648 | E.F.Mitchell | 12 |
| Ⓜ | 71 | J.E.Goldthwait | 17 |
| Ⓜ | 114 | J.C.Bloodgood | 16 |
| Ⓜ | 1382 | B.L.Coley | 5 |
| Ⓡ | 25 | C.E.Harris | 17 |
| Ⓡ | 721 | J.A.Caldwell | 7 |
| Ⓡ | 923 | Allegheny General Hospital | 14 |
| Ⓢ | 145 | W.B.Coley | 19 |
| Ⓢ | 1303 | B.L.Coley | 7 |
| Ⓢ | 389 | W.B.Coley | 9 |
| Ⓢ | 1086 | W.B.Coley | 8 |
| | | C, Fibula | |
| Ⓓ | 47 | G.E.Pfahler | 22 |
| Ⓛ | 322 | James Ewing | 14 |
| Ⓜ | 158 | G.E.Pfahler | 12 |
| Ⓣ | 90 | C.C.Simmons | 12 |
| Ⓣ | 480 | W.L.Robinson | 9 |
| Ⓣ | 745 | E.A.Codman | 10 |
| Ⓣ | 908 | A.C.Strachauer | 11 |
| Ⓣ | 1048 | G.W.Van Gorder | 5 |
| Ⓣ | 1140 | C.C.Simmons | 5 |
| Ⓣ | 1255 | C.C.Simmons | 5 |
| Ⓣ | 1417 | Loucks and Shih | 11 |
| | | D, Patella | |
| Ⓤ | 1162 | Ernest Kraft | 7 |

*Note that Case 896 had a tumor of the left tibia which was amputated by Dr. Bloodgood as a primary operation. Seven years later a tumor of the right femur was treated by Dr. Coley with a combination of various treatments and the leg was saved.

KEY TO TREATMENTS, TABLES I AND II

Ⓐ Primary amputation.
Ⓑ Amputation secondary to curettage.
Ⓒ Amputation secondary to radiation.
Ⓓ Amputation secondary to curettage and radiation.
Ⓔ Amputation secondary to curettage and toxins.
Ⓕ Amputation secondary to radiation, curettage and toxins.
Ⓖ Amputation secondary to toxins.
Ⓘ Amputation secondary to curettage and bone chips.
Ⓙ Amputation secondary to curettage, bone chips and radiation.
Ⓚ Curettage only.
Ⓛ Radiation only.
Ⓜ Curettage and radiation.
Ⓝ Curettage, toxins and radiation.
Ⓞ Radiation and toxins.
Ⓟ Coley toxins alone (exploratory operation).
Ⓠ No treatment.
Ⓡ Excision and radiation.
Ⓢ Curettage and toxins.
Ⓣ Excision.
Ⓤ Curettage.

merely to show that, without biopsy, there is some danger in undertaking treatment on an x-ray diagnosis. It is significant that the films in such a small proportion of malignant tumors resembled those of giant cell tumors. In fact, most of the films, even of those 12 selected cases, were by no means perfectly typical of giant cell tumor and might have aroused the suspicion of experienced roentgenologists. These 12 cases as well as 14 cases originally classed as giant cell tumors, but which proved to be malignant, are not included in the tables but are discussed separately. The tables, therefore, refer only to cases classed as cured. Table I shows 44 cases in which amputation was either the primary operation or became necessary after conservative treatment. Table II shows 47 cases in which the limb was saved. The key applies to both tables; by its use the statistically minded student may make subordinate calculations and by sending to the Registry at 40 East Erie St., Chicago, he may study the details in regard to the individual cases which interest him. The busy practical surgeon will take more interest in seeing the names of those who have taken the pains to register these cases. Most of them are already honored ones. He will also

be impressed with the long periods of years of survival in many of the cases, and must admit that the generally benign character of this form of tumor has been proved. In the future he will be more concerned about the function of the conserved limb and will not be content with merely saving it.

### GENERAL PRINCIPLES DEDUCED FROM THIS STUDY

1. The expansion and progress of these tumors is due to their pulsation, not to the malignant quality of their cells. Therefore, we should pay scrupulous attention to stopping their blood supply.

2. The persistence of a large cavity in the bone is one main reason for the inadequacy of the modes of treatment in vogue. Therefore, we should collapse the bony wall of the cavity and by using a flap of periosteum we may make the defect outside instead of inside the cortex.

3. We should bear in mind Wolff's law: that regeneration of bone tends to occur in lines of stress and absorption tends to take place where there is no stress. Therefore, we should place periosteum where new bone will be formed on the concave side of the defect, from which the tumor has been removed.

4. After operation we should support the limb, not only to prevent fracture, but in a manner that will assure stress in the normal line of weight bearing.

5. We should not jeopardize the normal repair process by the use of chemical or electrical cautery or by radiation.

### METHOD SUGGESTED BY THE AUTHOR

Without dwelling at present on the numerous arguments for each of these principles, I will submit to you a method of operation, which, to a great extent, complies with all of them. I suggested this method on theoretic grounds 2 years ago in my (unpublished) discussion of Mr. Platt's paper before this association, but since then I have had an opportunity to apply it in a case of giant cell tumor of the upper end of the tibia. As the plan was completely successful and as it confirmed the above convictions, a brief account of the case may interest you.

### CASE REPORT

CASE 1. The patient was a slight, wiry, healthy looking girl of Irish descent, aged 16. She was referred to me on November 8, 1934. Her parents, four sisters, and four brothers, were living and well. Two other brothers died in infancy. Three uncles and two aunts on the mother's side have died from tuberculosis.

Except for a cough which had persisted for 3 months and had cleared up in June, there had been no serious illness or accident until pain began in the right knee about July 1, 1934. It was not severe, though it was somewhat worse at night. She limped a little. In August, 1934, she first noticed some swelling just below the knee and in September she observed that there was also soft swelling about the ankle in the afternoon. This disappeared after a night's rest, although that about the knee did not do so. She had lost a little weight but felt well. At first she denied any injury but after careful questioning she remarked that 2 years before she had fallen while roller skating and had had a big bruise just below where the tumor is at present.

The physical examination corresponded with the accompanying roentgenogram (Fig. 4). Other films indicated that no other bones were affected and that the lungs were normal. Tuberculin and Hinton tests were negative, phosphatase 2.86, white corpuscles 16,000, red corpuscles 5,000,000, urine normal. There was 90 degrees' free motion in the knee joint, although a moderate amount of free fluid prevented the extremes of flexion and extension. The diagnosis was fairly clearly benign giant cell tumor.

Operation was performed by the writer November 21, 1934. Under a tourniquet, a curved incision was made on the inner side of the leg in the shape of a tongue, with the tip less than half way down the tibia and the base including about half the circumference just below the knee. The skin was dissected back, and a flap of periosteum was reflected, together with the insertion of the sartorious, from the upper third of the tibia, about half the circumference of the upper end of the bone being exposed. After the thin wall surrounding the tumor had been excised, the whole lateral and part of the posterior surfaces of the growth were exposed. Enough normal cortex was beveled off below the tumor to insure my being able to examine the lower margin in the medullary canal. I found that there was a sharp concavoconvex line between the colors of the two tissues, the reddish tumor tissue contrasting with the yellowish marrow. Touching this line with the blade of a knife gave the sensation that it contained an extremely thin line of bone trabeculæ. There seemed to be no other obstacle to the progress of the tumor down the medulla, except for hypothetical pulsation of the latter. The lateral wall of the tumor and a portion of the normal shaft of the tibia for about an inch below the tumor were chiseled off obliquely, in order that, later, the periosteum and soft parts could be adjusted to fill the cavity and packed in against the postero-external wall and the exposed undersurface of the intact cartilage of the tibia.

After removal of the tourniquet there was some difficulty in stopping the bleeding in the interior of the cavity. There was a definite spurter at the lower end in the region of the nutrient foramen. This was sealed off with bone wax. There were also similar bleeders near the joint edge at the upper internal angle of the cavity. By using bone wax the bleeding was thoroughly stopped, and by pushing in the tongue of periosteum the cavity was almost completely collapsed. This, of course, left uncovered a part of the normal medulla and some of the cortex at the lower end of the incision from which the periosteum had been removed; the skin was closed over this raw bone surface. The leg was put up in a bivalve plaster, which had been prepared beforehand.

The wound united by first intention and the patient was walking on crutches in about 4 weeks. Pains were taken to arrange a plaster boot so that it would gain its bearing on the shelf of the bone just below the knee, when she bore her weight on the foot. She was allowed to bear some weight in this way from the very first month and to increase the amount gradually until the crutches were discarded in

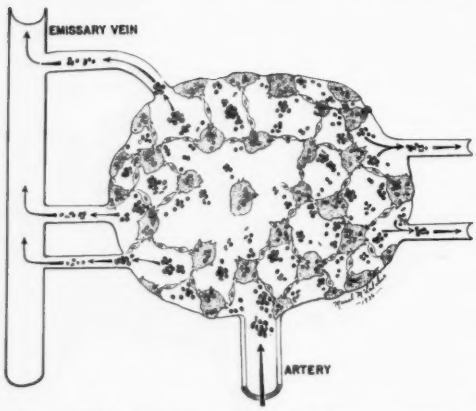



Fig. 1. The essential structure of a giant cell tumor is simple, for it contains no walled blood vessels and the corpuscles circulate through its interstices as if it were a sponge. Therefore, the whole sponge pulsates and tends to expand its bony walls by destroying its rigid boundaries. It does not advance down the soft marrow because the latter also pulsates with the same heart beats, nor does it invade joint cartilage which is elastic and accustomed to the intermittent pressure of weight bearing. After destroying the spongiosa it reaches the rigid cortex and finds its direction of least resistance where this is thin, near the ends of the bones, so that the heavy cortex of the tubular portions of a bone limits its progress down the shaft. I conceive the lumen of the artery which supplies it to be in direct communication with the interstices of the sponge and the emissary veins to be likewise the recipients of the corpuscles which have threaded their devious ways through the sponge. In Case 1553 (Miltner and Chang, Peiping, China) the artery of an amputated leg was injected with opaque material and film showed the sponge of the tumor and the emissary veins distended with the injection (Fig. 2, right).

Uncomplicated giant cell tumors contain no abnormal cells, although frequently endothelial leucocytes may appear in the stage of mitosis. The giant cells are not free, although they may appear so unless serial sections are made. They are nodes in strands of tissue remarkably evenly spaced throughout the cavity and line its walls. Complications in this simple picture include hemosiderin in nearly every case, indicating a traumatic origin, such as a fissure fracture without permanent displacement, which disrupts an artery and leaves it bleeding in the spongiosa. Endothelial leucocytes stuffed with marrow fat often appear and give a xanthomatous appearance to the gross tissue. In young persons cells from the epiphyseal cartilage complicate the picture. Necrosis and cyst formation, consisting of blood spaces lined with endothelium, occur when the current stagnates in portions of the tumor. The most confusing conditions occur when the bony wall is injured by fracture or surgery, when fibroblasts, osteoblasts, and the other cellular changes common in callus must be recognized. The writer believes that the late malignant changes, which sometimes occur, are due to these repair elements which lose their growth restraint after vainly trying to fill the cavity, which is devoid of endosteum. However, one rarely fails to find areas with the structure shown in this diagram, in some portion of the tumor. One must bear in mind, too, that areas of normal giant cell tissue may occur in malignant tumors in which there has been hemorrhage.

about 6 months. Soon after this the plaster boot was given up and she was allowed to walk naturally without any supporting splint. The risk of fracture was preferred to the chance of atrophy in consequence of disuse.

The accompanying films and photographs show the excellent functional result and the fact that new strong bone has been laid down on the concave side of the defect according to Wolff's law. They show, too, a slight amount of shortening of the limb, which probably took place prior to the operation from the interference of the tumor with the epiphyseal line (Fig. 4). Histologically the growth was a typical giant cell tumor.

### ADVANTAGES OF OPERATION

This operation checks all bleeding and obliterates the cavity, instead of inviting sepsis by packing or closing the wound and trusting to aseptic blood clot, or by filling the cavity with bone chips. The latter at first seems logical, but it conflicts with Wolff's law, for the chips are not in lines of stress and become absorbed.

One might object that the operation which I suggest does not differ much from a well carried out curetting, especially when muscle or other adjoining tissues are used to fill the cavity. It does, however, differ materially in the following ways:

First, in order to make sure of a long periosteal flap, the normal bone is entered at a considerable distance from the tumor and the medulla is exposed well below the boundary line between tumor and marrow. The great advantage of doing this is that the character of this concavo-convex boundary line may be observed, for its shape is so constant in giant cell tumors, as opposed to that seen in malignant sarcomas, that recognition of its presence is almost as reliable in diagnosis as is microscopic examination of the tissue.

Second, since bone forms along lines of functional stress, the tongue of periosteum is laid in on the concave side of the defect left by the removal of the tumor. Thus the defect is made external to the periosteum, and as time passes more periosteal tissue will be laid down in the lines of stress. At no time will there be a cavity within rigid walls such as exists after curettage.

Third, another advantage is that the bulk of the tumor can be scooped out in one mass; hence every opportunity is given the pathologist. As a matter of fact, the manner in which this type of tumor may be shelled out to leave a definite cavity, and the observation of the abovementioned sharp division between tumor and medulla, are quite reliable diagnostic points, perhaps better than the opinion of even a good pathologist on a small bit of tissue or that of an inexperienced pathologist on a large piece. At this stage the surgeon himself should be able to decide whether

Fig. 2. Case 1553. Some of the most carefully registered cases which we have have come from China. This one is alluded to in the legend of Figure 1. The excellent sections taken from the tumor were those from which that diagram was made. When comparison is made of the roentgenogram before amputation with that of the injected specimen, one can realize that in the former the superficial veins carrying normal blood corpuscles were the same as those made visible in the latter by the particles of injected material, which had passed through the vascular network of the tumor.

or not to amputate. If he finds invasion of the marrow, he certainly should amputate.

Fourth, it differs from curetting and closing the wound in the fact that it does not rely on packing or on aseptic blood clot to fill the cavity. It relinquishes any idea that it can be filled from within. Nature does not seem capable of replacing a clot with spongy bone, for all the endosteum has been destroyed by the tumor. Every surgeon will realize after once doing subperiosteal excision that it appeals to his surgical sense, and that he may expect primary union instead of wondering whether he will attain it after curetting and closing the wound.

In this case no chemical cautery was used, for I do not think it is at all necessary to kill small numbers of giant cells which may remain in the interstices of the tumor wall. I fear these cells less than the chemical, for the latter may destroy the living normal cells which are useful in repair. I did not even destroy or curette the inner wall of the cavity. No radiation was used, nor did it seem to be best to use Coley's toxin.

The result in this case was excellent and prompt. Normal function of the limb was soon secured with practically no pain in the convalescence. There were no painful dressings and no open wound or sinus to discourage the patient. It is now nearly 2 years since the operation, and according to Wolff's law the bony deformity is disappearing and will probably continue to do so. I even hope that spongiosa may appear.

### CHANCE OF ERROR IN DIAGNOSIS

Perhaps I made a mistake in making no effort to destroy the remaining cells in the cavity. Even assuming that one has technically good films and microscopic slides and the availability of experts to interpret them, there are three chances of error in a roentgen-ray diagnosis of giant cell tumor, and two when tissue has been examined.

1. The films may be characteristic but the slides unequivocally in favor of some other diagnosis.

There are at least 12 cases in this class (Cases 130, 154, 473, 566, 592, 712, 795, 1288, 1392, 1641, 1697, 1765). These 12 doubtful cases form a considerable percentage when compared to our 150 cases of giant cell tumor, but the number is small when compared to the 600 cases of malignant conditions in the bones of the knee from which they were selected because they were of dubious interpretation. Roentgen-ray diagnosis is very reliable if the interpreter has sincerely studied the literature of bone tumors, but there will occasionally be a serious error. In case 1765, although the history is of only 4 years, the roentgenogram and slide indicate that the condition was originally a giant cell tumor, probably of longer than 4 years' standing. The registry museum has one-half the

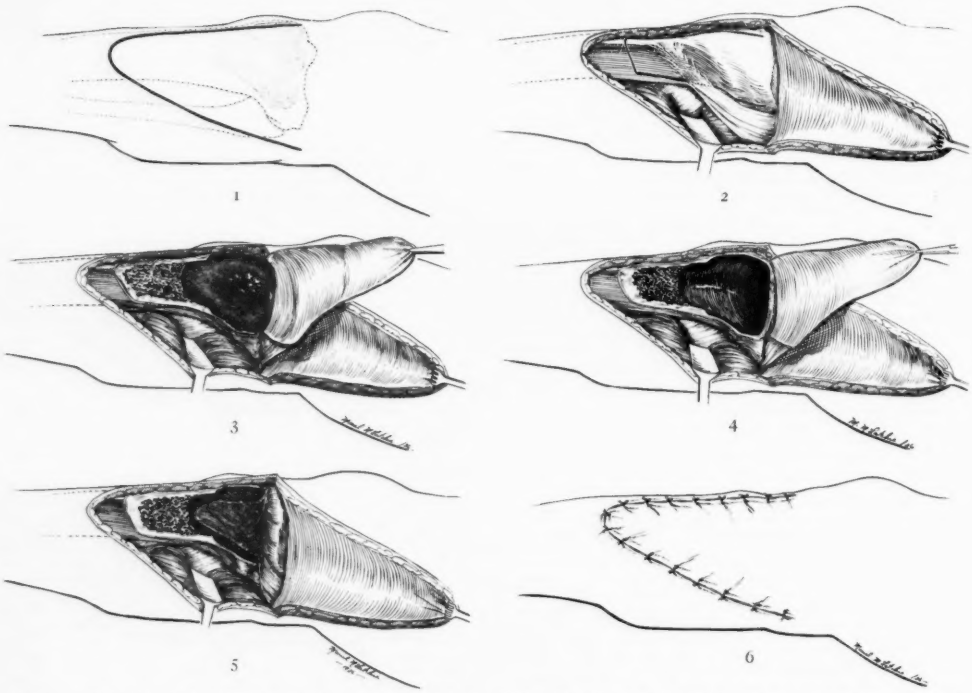



Fig. 3. Subperiosteal resection with collapse of the cavity. The incision here indicated was needlessly large, and while it united by first intention in this case, it is believed that the incision indicated in the next figure would have been adequate, for there is always a risk of necrosis when a tongue shaped flap is used. The flap of periosteum must be taken well below the tumor, not only to ensure a flap long enough to cover the concavity of the defect, but to admit inspection of the concavoconvex line which is characteristic of a giant cell tumor where it adjoins the marrow. In taking the flap of periosteum the "cambium layer" and even spicules of the thinned cortex should be used. The bony wall is not a dangerous tissue except in the sense that too much of it might invite giant cells as scavengers. Note in 4 that a bit of cortex became incorporated in the new formed bone. The flap is not expected to cover the exposed marrow which will take care of itself when the skin flap is closed over it. The latter will be slack and can be pushed in toward the defect by a gauze pad in the dressing under the previously prepared bivalved plaster. Both the lateral and the posterior walls of the tumor can be removed. It is not necessary, however, that the edges of the defect be covered with the periosteal flap.

specimen for study and very beautiful sections have been made which show giant cell tumor and sarcoma both present.

2. Both films and slides may be interpreted as giant cell tumor, yet the case may run a rapidly fatal course, indicating that an error of interpretation was made. All of the patients in this group died within 5 years of onset.

Ewing reported Case 349 in detail.[1] This was a boy of 19 years with a tumor of the upper end of the tibia who was treated under the diagnosis of a giant cell tumor, but who died of metastases 2 years from the date of onset. Ewing discussed the question of whether this case was originally a giant cell tumor which became malignant, or whether there was an error in microscopic diagnosis. The same applies to the following cases:

Case 1160. A tumor in the upper end of the tibia in a man of 33. Registered by Dr. A. P. MacAusland of Boston. The period from onset to death was less than 2½ years. Both the original roentgenogram and slide seemed characteristic of giant cell tumor, yet the case ran a malignant course in spite of the fact that the leg was twice curetted thoroughly, and finally amputated, before signs of metastases appeared.

Case 1406. A giant cell tumor of the lower end of the femur in a man of 34, who refused treatment for 3 years before consenting to amputation. He died 1 year after amputation with x-ray evidence of metastases to the lungs.

This case was registered by Joseph A. Wark of Barrie, Vermont, and is a very interesting one, because Dr. Wark

[1] Arch Surg., 1933, Sept.

October 22, 1934. December 10, 1934. May 20, 1935.

April 10, 1936.

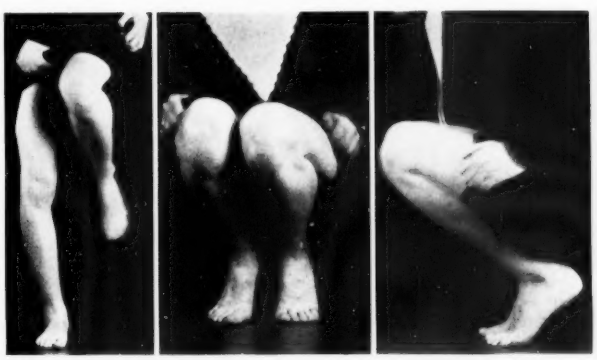


Fig. 4.

Fig. 4. Case registered as No. 1953. Author's case of subperiosteal resection with collapse of the cavity. In the final roentgenogram there still appears to be a cavity, but this appearance is probably fallacious, because the actual shape of the present internal condyle is that of an overhanging shelf of firm bone with a recess beneath it. However, if the blood supply was not absolutely stopped in some part of the cavity, or if the cells of the tumor are capable of autonomous new-growth, there is still a chance of recurrence of the tumor, for no effort was made with curetting, chemical cautery, or postoperative radiation to check the growth of tumor cells which undoubtedly still existed in the interstices of the wall of the cavity. The inner wall of the tumor consisting of very thin bone, which separated the tumor from the adjacent trabeculæ, was not disturbed. In other words, the author believes that the bony boundaries of such tumors are innocent, and that removal of the inner wall would merely cause increased bleeding with a chance of formation of a similar tumor.

secured the specimen for the museum of the College. Careful examination of this specimen shows a giant cell tumor with some suspicious areas of spindle cell tissue.

There can be no doubt in this case that a diagnosis of giant cell tumor was justified and yet metastases caused death in about a year. Unfortunately, no autopsy was obtained and so the histological type of the metastases could not be determined. However, Cases 171, 519, 1518, 1521 illustrate the difficulty in diagnosis even in expert

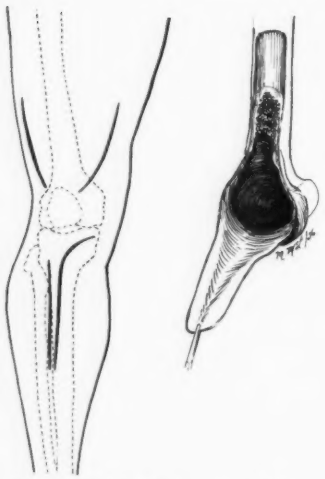


Fig. 5. Lines of incision for exposure of the condyles of the femur and tibia. The writer recently had an opportunity to use a leg, which he had disarticulated at the hip joint for an osteogenic sarcoma of the upper femur, to study the method of approach to the condyles. Through the incisions indicated in heavy lines, it was found quite easy to expose them and to take long periosteal flaps as indicated in the figure to the right. By separating the muscle bundles of either the vastus internus or externus, the lateral surface of the condyles could be attacked without opening the joint capsule which was readily pushed toward the median line of the femur.

It is held that the removal of the thin, distended walls of a giant cell tumor only slightly weakens the architectural support of the limb. These tumors are as a rule unicondylar and the normal condyle continues to bear the bulk of the weight, especially if a lift in the sole of the shoe is provided. Weight bearing should soon be encouraged so that new periosteal bone will form on the concave side of the defect. In both the tibia and the femur there is very strong bone about the rim of the joint, and most films show that this rim is not weakened by the tumor which finds less resistance in the thin cortex just below or above the joint.

hands, for three of them were treated at the Memorial Hospital in New York and one, 519, was listed by the writer as a giant cell tumor. Case 1804 is a similar one and the amputated specimen showing an undoubted sarcoma is preserved at the Pondville Hospital. Unfortunately we have not been able to secure the first slide on which the original diagnosis of giant cell tumor was made at one of the Naval hospitals.

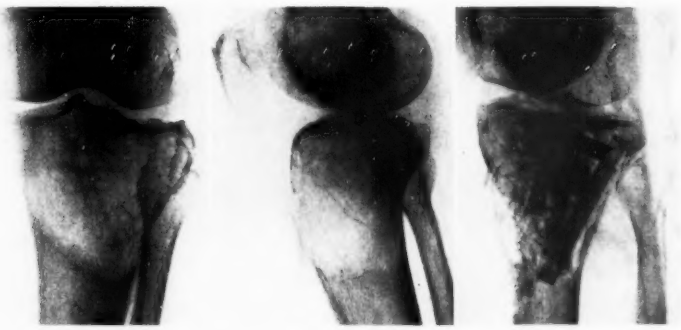
3. Films, slides, and the clinical course for several years may make the diagnosis seem assured, yet eventually sarcoma may appear at the site of the lesion.

Cases 244, 679, 917, 1033, 1053, and 1133 are illustrative of this. All six of these patients lived over 7 years from the onset. This long period justifies the belief that there was a sarcomatous degeneration of a giant cell tumor rather than that there was an error in diagnosis on the first specimen, because a true osteogenic sarcoma usually runs a short course. Case 244 was studied at the Peter Bent Brigham Hospital, although the original operation was not done there but at the Boston Dispensary. We have a series of slides showing increase in the loss of gross restraint, after attempted conservative operations. Cases 679, 917, and 1053 showed malignant changes after x-ray treatment not complicated by surgery. They illustrate the danger of supposing that an x-ray cure is established after 5 years.

We might, in all these cases, attribute the mistakes to faulty technique or incomplete data, but there are enough instances in each class to furnish undeniable examples. As a matter of fact, clinically, the patient must accept his fate in many instances where the data are incomplete, technically poor, and interpreted by persons of little experience. Such cases are not registered. It is likely that those registered are above the average in technical excellence and in the intelligence of the study given to them. To be sure, many of them were registered years ago when x-ray technique was less accurate, but even today a hospital which can show uniformly good films, slides, interpretations, clinical records, and protracted follow-up of its patients is the exception, not the rule. Therefore, we may assume the actual percentage of errors through the country to be even greater than in this series.

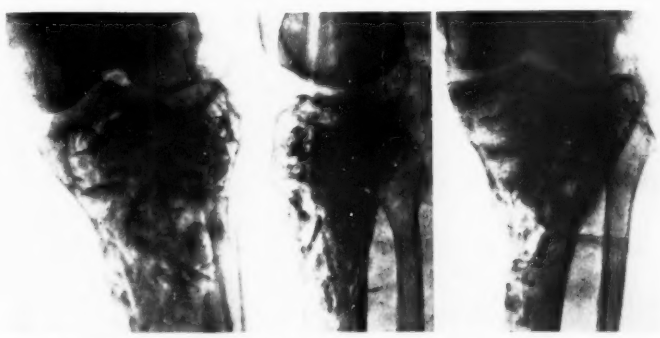
I am not greatly impressed by these statistics, for I have studied the records of all the cases in detail several times, at intervals of years from the time when they were first registered and my opinion was written on the diagnosis sheets. These cases cannot be used for percentages. They are too uncertain. Each of these doubtful cases should be regarded as an individual study because none of them was perfectly registered and opinions about them might legitimately differ. My colleagues and I wrote our opinions on most of the cases before the outcome was known, and in a few, our diagnoses have proved to be incorrect, but the tables indicate that in the great majority the ultimate results have supported our original prognostications. With good x-ray films, adequate biopsy and expert interpretation, the chance of error in giant cell tumors about the knee is certainly not greater than the 7½ per cent estimated by Simmons[1] from the study of all the registered cases in all the bones. It is almost the same percentage as the chance of saving the pa-

[1]Surg., Gynec. & Obst., 1931, 53: 46.



August 29, 1933. Before operation. September 11, 1933—filled with bone chips.

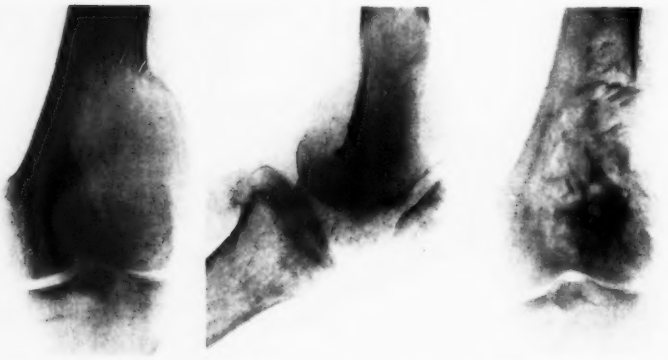
10 weeks after first operation. Chips beginning to dissolve. Chips completely dissolved 1 year after first operation.



1 week after filling with bone chips the second time. 5 months later, again dissolved, septic. Amputation.

Fig. 6. Nine views of Case 1615. Patient was operated on at the Massachusetts General Hospital. The fate of bone chips used to fill a giant cell tumor cavity is shown. The case is particularly instructive because the first operation was technically beautifully done; the wound united by first intention and for the first few months the operation seemed highly successful, yet complete absorption of the chips occurred within a year. A second attempt likewise failed and amputation had to be done. Case 1782 was also an unsuccessful one. According to Wolff's law such an outcome is to be expected, for unless the chips are in lines of stress, they act as foreign bodies and demand giant cells from the normal protective mechanism of the body. To introduce them is to stimulate the formation of tissue similar to that of which the tumor is composed.

tient if amputation is performed, and the tumor proves to be a malignant one. In other words, if we amputate in every case we think to be benign, we do not correct the 7½ per cent of chance of death from malignancy, for we shall save only about 7½ per cent of the 7½ per cent which are not benign. We should sacrifice more than 99 limbs to save 1 life. In the future, amputation can



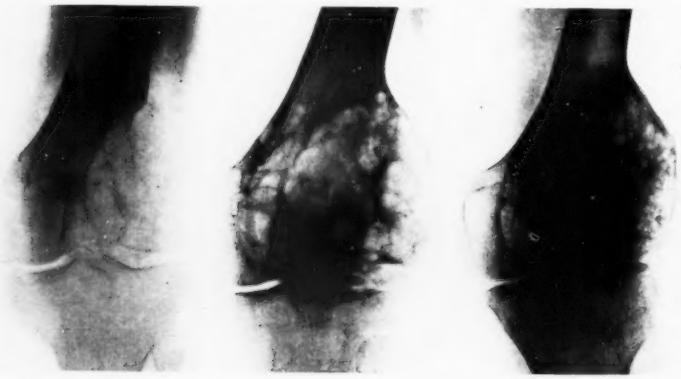
Reg. No. 1782.
Deceptive lateral view, old shaft appears within tumor.

Filled with bone chips.

Reg. No. 580. Note fracture.

Reg. No. 646. Patella shadow overlies defect.

Reg. No. 358. Atypical, near joint.



Reg. No. 520. August 9, 1924, before curetting.

January 16, 1928, advance process, x-ray treatment.

November 20, 1930. Stationary, leg useful.

Fig. 7.

Fig. 7. Five instances of giant cell tumors of the external condyle of the femur. Most tumors of the tibia and femur are unicondylar; probably all are in their early stages. In the femur the internal condyle is most commonly involved; in the tibia the external. The fact that this is true is in accord with the supposition that they arise from fissure fractures because the incidence of complete fractures is in a similar ratio.

The three upper figures are from one case in which bone chips were used but became absorbed. The middle figure illustrates a deceptive point in trusting a lateral exposure. The old shaft seems to be in the tumor but the first figure, the anteroposterior view, shows that the tumor occupies the external condyle. When a tumor really surrounds the shaft, it is almost certainly an osteogenic sarcoma.

The first figure also shows an unusually high extension in the tubular portion of the bone. This indicates a large vascular connection and an aggressive tumor, suggestive, but by no means proof, of malignancy.

In Case 580 there is a fracture. This should not in itself indicate amputation because we have records of cases which have recovered under conservative treatment and it is conceivable that the fracture itself may lead to recovery, for it opens the way to fibrosis.

Case 520 is one in which fracture had occurred and was seen by the writer when recurrent after curettage. Roentgen-ray treatment; 12-year cure.

Case 646 illustrates the danger of misinterpretation from the projection of the patella.

Case 358 shows a suspicious point in that the tumor does not appear to extend to the joint cartilage. However, in the lateral view it is shown to extend to the joint surface in the whole anterior part of the condyle.

Roentgenologists should be encouraged to locate these tumors more exactly and to study out ways in which each condyle can be projected on the film. Subperiosteal resection is more likely to be done if the operators realize that these tumors are usually unicondylar.

TABLE III.—FORMS OF TREATMENT

| Type of treatment | Objections | In favor of |
|---|---|---|
| 1. Amputation | Loss of leg.<br>Metastases, if the tumor is really malignant, probably have already been disseminated.<br>99 limbs lost to 1 life saved. | Possible cure if true sarcoma; sure cure if giant cell tumor.<br>Slight surgical risk.<br>Whole specimen for prognosis.<br>An artificial leg is good.<br>Doubt relieved. |
| 2. Curettage | Surgical risks great.<br>Sequelæ as: osteomyelitis, cavity, sinuses, recurrence.<br>Painful and repeated dressings.<br>Deformity likely.<br>Loss of function likely.<br>50-50 chance of ultimate amputation.<br>Protracted doubt of recovery. | A specimen is obtained.<br>The leg may be saved although amputation may have to be done later.<br>Registered examples |
| 3. Curetting and filling cavity with bone chips | Bone chips dissolve unless in line of stress.<br>Presence invites osteolysis by giant cells.<br>Protracted doubt of recovery (no instance of success registered).<br>Surgical risks. | Can be closed by first intention.<br>Might possibly fill cavity.<br>Amputation can be done later. |
| 4. Resection with arthrodesis or graft | Stiff leg.<br>Shortening.<br>Surgical risk.<br>Fracture later.<br>Some doubt of recovery. | Prompt result.<br>Leg saved, though stiff.<br>Specimen obtained.<br>Amputation can be done later. |
| 5. Coley toxins | One registered cure.<br>No specimen unless risk of biopsy is taken.<br>Suffering; protracted doubt.<br>(Has too frequently been combined with other treatment.) | Possible 100 per cent of function retained.<br>Supporting apparatus and chance of spontaneous cure. |
| 6. Roentgen-ray or radium | No specimen obtained.<br>If biopsy, some of the risks of curetting.<br>Enlargement persists in peripheral bone.<br>Danger of fracture, burns, bone atrophy, etc.<br>Protracted doubt of recovery. | Possible 100 per cent of function retained.<br>Leg saved.<br>No operation.<br>Function likely to be good.<br>There are registered cures although most of them had curetting also. |
| 7. Subperiosteal resection (proposed by author) | Danger of fracture or collapse possibly increased, although only very thin bone is removed.<br>Some surgical risk.<br>Only one example to follow. | Doubt relieved.<br>Leg saved.<br>Low surgical risk.<br>Normal function.<br>Prompt recovery.<br>No deformity.<br>Cavity obliterated.<br>Does not trust blood clot.<br>All advantages of curetting without its disadvantages.<br>Specimen obtained complete, hence little risk of error in diagnosis.<br>Renewed bone formation likely.<br>Complications minimized. No pain. |

be advised only when exploration shows malignancy, or when strictly surgical conditions such as sepsis, hemorrhage, or deformity indicate it. The method of operation which I propose is a biopsy in the true meaning of the word; it permits a complete visual examination of the whole living tumor. Just as an ordinary biopsy did prevent error in the 12 cases in the first class, I believe this more extensive form of biopsy would have prevented most of the errors made in the 14 cases included in the second and third classes.

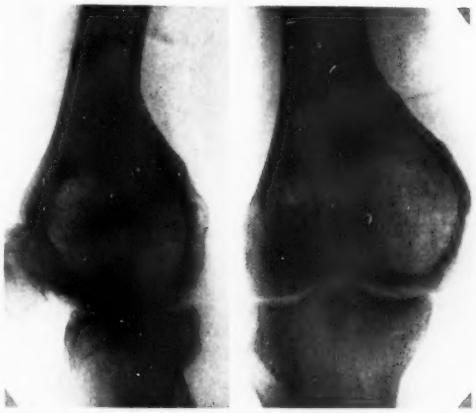


Fig. 8. Case 27. This case is important because, in spite of the fact that treatment was refused, the patient, a farmer, now 40, is living and well with a useful leg 20 years after the tumor was first noticed. This roentgenogram was made about 8 years after the first one, which was typical of the usual giant cell tumor of the internal condyle. During the interim the peripheral bone has become greatly thickened, especially on the edges of the joint cartilages, but the cavity within still exists. Many of our cases of long duration exhibit this appearance. This case was registered by Dr. C. H. Harris of Fort Worth, Texas, who has been most obliging in trying to follow the case for the Registry. The patient is refractory and as he lives in a distant place I quote a recent letter from Dr. Harris:

"On September 29th I drove down to G———, Texas, and encountered Mr. ——; found him in his town. It was a 150 mile drive for nothing because, although he was very pleasant, of his aversion about having an x-ray picture made. I told him there was no charge and I offered to pay him for his time and his fare and back, but he would not make a promise.

"He walks on his leg but there is a slight bowing outward; otherwise there is very little loss of function. He limps because of habit, although he states that there is a slight amount of weakness in the limb. There is no enlargement of the bone and there is 90 per cent flexion and extension, and he looks healthy and well."

It is not unlikely that the various forms of treatment are effective in proportion to the degree in which they check the blood flow. This case and others suggest that nature can do much unaided. Possibly our roentgen-ray cures are due to primary stagnation of the blood stream in these tumors, and Wolff's law guides repair. One wonders whether ligation of the nutrient vessels, intensive diathermy, injection of the tumor with sclerosing solutions, etc., might not be effective. These large tumors have always tempted surgeons to attack them. What is their natural history if let alone?

### METHODS OF TREATMENT

There is much to be said in favor of roentgen-ray treatment. The writer feels that he is not prejudiced against it, for two instances of 12

year cures by this method were obtained in cases which he saw in consultation and for which he advised radiation. Both are well, with fair function, today. One (Case 648) is the only recorded case of a roentgen-ray 10 year cure of a giant cell tumor of the upper end of the tibia, not complicated by surgery. The other (Case 520) is one of the 10 year cures of giant cell tumors of the femur which had recurred after curettage. Yet in the case herewith reported I felt that the risk of error by roentgen-ray treatment alone was too great to chance again, and that it was advisable to try the method of operation illustrated here, as the best way to assure saving of life, limb, and function.

The accompanying abstract of the arguments for and against the different methods of treatment (Table III) is supported by the analyses of the histories of the cases.

## CONCLUSIONS

From this study and analysis, it seems clear that patients with giant cell tumors about the knee are almost always cured by amputation and *may* have their limbs saved by the use of resection, curettage, radiation or by their combinations. One case is recorded in which recovery occurred after an exploratory operation followed by Coley toxins and one which has remained stationary for a period of 20 years without treatment.

The impression one gets from study of the individual cases, is that many patients have suffered unnecessarily because treatment has not been persisted in by a single method adequately followed through. One should have the courage to choose a form of treatment and then trust it. The mere fact that these tumors enlarge soon after being radiated should not lead to the adoption of surgical treatment, for this enlargement is a constant phenomenon in the early stages of radiation therapy. On the other hand, the after-treatment of curettage is most important and may be neglected in busy clinics. The fact that so many cases have come to amputation after going through the torments of unsuccessful conservative treatment is distressing.

However, now that the generally benign character of this form of tumor must be admitted, and it has been made clear that conservative treatment of various kinds may save the affected limbs, even though these remedies have, in many cases, been applied illogically and under disadvantageous conditions, it seems that the time has come to consider the degree of usefulness to be expected to follow each method of treatment. Unfortunately, the reports, hitherto, give little detail as to the amount of deformity or of loss of function; that the patient is living and using the leg appears to content all concerned. Some bony deformity and a considerable restriction of motion appear to be the rule. In a few cases excellent function and no obvious deformity have been claimed, after treatment by either radiation or curettage when used separately, but seldom in cases in which they were combined.

Those who have registered the successful cases in the above series are urged to report to the Registry as to the exact amounts of loss of function, disability, and deformity now present in their patients. This is a co-operative venture in medical science; many can supply the facts about single cases and now and then someone will be found who has the enthusiasm to study these facts and draw conclusions from them which may add to scientific knowledge or to the safety and efficacy of treatment. If the suggestions of the writer as to the merits of subperiosteal excision prove important, each surgeon who has registered a case of bone tumor may feel that he has done his bit in helping to confirm the advances made by Gross, Coley, Bloodgood and Pfahler and in furnishing the material for another forward step in the treatment of giant cell tumors.

# PANEL DISCUSSION: CANCER CLINICS

## EXTENSION OF THE TUMOR CLINIC SERVICE TO INCLUDE PRIVATE PATIENTS

ROBERT B. GREENOUGH, M.D., F.A.C.S., Boston, Massachusetts

THE interest and enthusiasm which have been aroused by the movement to create a degree of specialization in the diagnosis and treatment of cancer, by the establishment of tumor or cancer clinics in general hospitals, has been made evident, not only by those especially interested in the cancer problem, but by hospital staffs and administrative officers and by the general public as well. It is not illogical, therefore, to assume that such benefits as accrue to the cancer patient by reason of a group consultation service in the charity clinic, could and should be extended to the private patients in the private wards of the hospital, who are not charity cases, but are able and willing to pay fees for medical service.

The question at once arises as to how such an extension of the service can satisfactorily be brought about. There is a strong prejudice among private patients against being brought as a patient to a free clinic. This is partly sentimental and is also partly due to the keener sensibilities of the private patient and his reluctance to abandon his customary privacy and independence. The matter of fees enters also into the problem, and to send a private patient who is able to pay for medical service to a free clinic is an injustice—to the private patient, to the other charity patients in the clinic, to the hospital, and to the medical staff as well. In short, we must acknowledge at once that the pay patient does not belong in the free clinic, and that some other method must be devised by which he may obtain the desired group study and consultation to which he should be entitled.

In our modern civilization, persons who are able to pay for medical service can be divided arbitrarily into two classes: (1) those who can and should pay only minimum fees; and (2) those of larger resources, who can pay fees approaching at least the actual cost of the medical services rendered.

Presented in the Panel Discussion on Cancer Clinics, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

These two classes of the population find accommodation today in our modern hospitals in the so called "semiprivate" and the private wards. In smaller institutions, the accommodations for patients of both these groups are not physically segregated, but in a number of larger institutions, separate buildings and a separate administrative and nursing staff are provided for private patients and for the wards for those of "moderate means."

This arbitrary separation into two classes of the private and paying patients makes it necessary to devise methods of organization which will permit the hospital to provide equally efficient service to the two groups, and at the same time to keep the expense of the semiprivate patient at a minimum.

Such a reduction of expense is made possible, so far as the hospital itself is concerned, by applying the principle of mass production. Thus in 2, 3, and 4 bed rooms more patients can be cared for at less expense than in single rooms. The administration, housekeeping, and nursing care cost less per patient day in such a ward, and even laboratory and x-ray service can be delivered at a lower figure.

The concentration of the physicians' and surgeons' work under one roof is a saving of time and energy which permits reduction of fees for medical and surgical service, and consultations are so facilitated that a minimum fee can be established to the material advantage of physician and patient alike.

It is this fact which makes possible the extension of the tumor clinic service to the private patient of moderate means. Every cancer patient today should be entitled to a group consultation between the medical or surgical clinician to whom he has entrusted himself, and the radiotherapist and the pathologist. The pathologist's participation in this consultation may be postponed until pathological material from a biopsy, or otherwise, is available for study, but the surgeon and the radiotherapist should work together from the beginning to obtain the best results. The patient in the semiprivate ward is primarily the private

patient of the clinician who procures the former's entrance to the hospital. As soon as the routine preliminary study of history, physical examination, and laboratory data has been accomplished, and as soon as such additional special examinations as may be required in the individual case have been made, the consultation with a representative of the radiotherapy department should be held. The diagnosis and treatment are discussed and a plan of treatment determined. If a biopsy is necessary, this consultation may be postponed until the pathologist can report the findings, and he should then join in the consultation. For such participation, both the pathologist and the radiotherapist should receive at least the minimum consultation fee. When the plan of treatment has been determined, whether by surgery, by radium, or roentgen ray or by any combination of these agents, the treatment is given and the patient is returned to the care of his attending physician with instructions to report for follow-up. In this way the private patient obtains all the advantages of the tumor clinic consultation service and avoids the stigma of receiving charity service to which he is not entitled.

In the private ward exactly the same procedure may be followed, the only difference being that the consultation fees should be increased to a point commensurate with the patient's resources and with the cost of the service rendered estimated in time and effort consumed, as well as in relation to the special experience and the acknowledged reputation of the consultants.

Such an extension of the tumor clinic principle to include the private and semiprivate wards of the hospital increases materially the value of the tumor clinic records for statistical and other study and experience. To make this fully effective, however, records of such patients must be obtained of the same complete character as those required for the tumor clinic files. The responsibility for the preparation of these records must rest with the clinician responsible for the patient's hospital entry; but facilities for the dictation and supervision of such records can readily be provided by the Hospital itself in the clerical service of the tumor clinic. In this repect the co-operation of the hospital staff must be secured. In any case, index cards, with name, diagnosis, and reference to the hospital record by number and with the name of the attending physician, should be filed with the tumor clinic records.

The follow-up of private patients must, of course, be left to the initiative of the attending physician, but requests for follow-up information from time to time, sent to the patient by the tumor clinic record clerk, may be expected to encourage the members of the hospital staff to devote more energy to this important responsibility of the physician who undertakes to care for cancer patients, to the benefit of all concerned.

The plan suggested is not, so far as I am aware, in actual formal operation anywhere, at the present time. It is based, however, essentially upon the method of conduct of private cancer cases which has been developed spontaneously by the members of the tumor clinic staff of the Massachusetts General Hospital in relation to their private patients, in the Phillips House (the private ward), and in the Baker Memorial (the ward for patients of moderate means).

# CANCER CLINIC IN A GENERAL HOSPITAL WITH PUBLIC AND PRIVATE PATIENTS

CHARLES K. P. HENRY, M.D., F.A.C.S., F.R.C.S., Montreal, Quebec, Canada

IT is my purpose to present a brief outline of the method used in the Montreal General Hospital in the treatment of cancer and other malignant tumors. This hospital is composed of 600 beds for private, semiprivate, of which there are two classes, A and B, and public patients; roughly, two-thirds are at the old, central division, one-third, at the new, western site.

TABLE I.—THE MONTREAL GENERAL HOSPITAL—600 BEDS

| Beds | Central | Western | Total |
|---|---|---|---|
| Public | 353 | 59 | 412 |
| Semiprivate | | | |
| Class A | 22 | 6 | 28 |
| Class B | 29 | 0 | 29 |
| Private | 21 | 110 | 131 |
| Total | 425 | 175 | 600 |

We have a staff of about 175, and, as the hospital is a closed one, the private and semiprivate beds are available only to our own staff, and to privileged members of the other university hospital staff, the Royal Victoria Hospital.

Time will permit of the presentation of only one side of our treatment and its control. I refer to radium, its use, control, records, and results obtained. We possess 615.27 milligrams of radium, in the form of needles, tubes, and plaques of various sizes. The needles are of English manufacture and have the Hopwood eye.

TABLE II.—RADIUM SUPPLY OF MONTREAL GENERAL HOSPITAL

Total amount of radium, 615.27 milligrams, September, 1936.

| | No. | Milligrams |
|---|---|---|
| Tubes | 5 | 25.0 |
| | 2 | 50.0 |
| Plaques | 1 | 2.5 |
| | 1 | 11.5 |
| | 1 | 20.09 |
| Needles | 34 | 0.5 |
| | 10 | 0.66 |
| | 35 | 1.0 |
| | 57 | 1.5 |
| | 55 | 2.0 |
| | 30 | 3.0 |
| | 6 | 5.0 |

Presented in the Panel Discussion on Cancer Clinics, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

The radium committee has absolute control of this radium, and determines who may use it; and the personnel of the radium room is responsible to this committee.

TABLE III.—ORGANIZATION OF DEPARTMENT

TABLE IV.—PERSONNEL OF COMMITTEES

| | |
|---|---|
| Radium Therapy Committee—10 members | Three surgeons |
| | Gynecologist |
| | Dermatologist |
| | Otolaryngologist |
| | Pathologist |
| | Roentgenologist |
| | Director of Records |
| | General Superintendent |
| Executive Committee—4 members | Two surgeons |
| | Gynecologist |
| | General Superintendent |

In this general hospital each service treats cancer cases, and each service has one or more members trained in the use of radium for that particular specialty. For instance, in the gynecological service, one attendant looks after and treats every cancer case requiring radium, whether in the in-patient or out-patient department. On our staff of 175 there are only 18 members who have the privilege of using radium, either for public or their own private patients. Of the 18 there are several who may use radium only for certain types of cases when such treatment is approved by the chief of service.

*Every* patient, whether private or public, who receives any form of radium treatment, alone or combined with surgery, x-rays, or other form of treatment, has a record filed on the appropriate

Fig. 1. Radium room showing open door into workroom.

Radium National Form of Great Britain. These records are kept in the radium room, and at any time are available for reference, follow-up, and study. The x-ray department is adjacent to the radium room at the central division, where there are three Victor Corporation therapy machines, one a shockproof oil cooled 200 kilovolt, and two 135 kilovolt machines. In addition, there is, at the western site, another shockproof 200 kilovolt new machine. The director of this department, Dr. W. L. Ritchie, is an active member of the radium therapy committee, and is in daily consultation with all staff members treating cancer cases. The radium room is centrally located, close to the entrances for in-patients and out-patients, with convenient waitingroom facilities, and adjoining the diagnostic and treatment rooms in the x-ray department. There are two cubicles for cases under treatment, where patients may sit or recline, while under the control of the radium room personnel. Our safe has been checked, and

Fig. 2. One of the cubicles in the radium room.

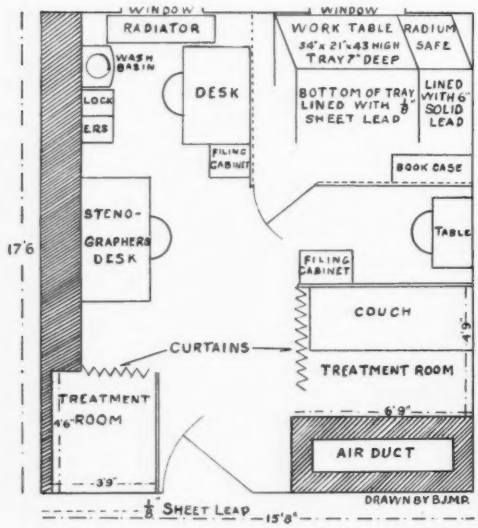



Fig. 3. Floor plan of the Montreal General Hospital radium room.

Fig. 4. Work room with bench and chest protector and lead safe for radium stock.

found to allow of no leakage of radiation; and the workroom partitions and door are, in addition, lead lined (Figs. 1–4). Return cases may be seen here, or elsewhere; the radium records are delivered anywhere in the hospital, and returned, at the request of any attendant. Cancer cases not treated by radium are reported on the usual indoor or outdoor records; but in many cases their follow-up is undertaken by the radium room staff. At present, arrangements are being made to provide a common room for the return and follow-up of all cases of cancer treated by the general surgical staff.[1] The departments of gynecology, dermatology, otolaryngology, and urology have the same indoor and outdoor staff, and each department has its own follow-up system, but each reports all radium cases on the regular National Form.

In the gynecological department all cases of carcinoma of the cervix are treated by one doctor, and since July, 1925, of 235 patients, there were only 2 who were not treated with radium alone. One of these, with a complete prolapse of the uterus, had a vaginal hysterectomy; the other case had a hysterectomy for a submucous fibroid, and at operation, the accidental finding of a carcinoma high in the cervical canal was made.

TABLE V.—CANCER OF THE CERVIX—THE MONTREAL GENERAL HOSPITAL, JULY, 1925, TO JULY, 1929

| Condition | Numbe | Alive and well | Percentage |
|---|---|---|---|
| Operable | 16 | 13 | 50.0 |
| Borderline | 10 | | |
| Inoperable | 34 | 11 | 14.6 |
| Advanced inoperable | 41 | | |

In all 24 cases are alive and well—23.7 per cent.
Dr. Eleanor Percival.

The total figures for the radium department are not yet available for the first 5 year period—April, 1929, to March, 1934; but, to some extent, my own cases are a fair estimate of the results obtained. Of these 94 cases, radium alone was used in 43 cases, while in the 51 cases remaining the patients were treated by radium and surgery, or by various combined treatments.

Some of the patients reported as alive and well include several who lived 5 years or more without recurrence, but later died of other diseases. Of the alive and well cases reported, there is only one patient alive with recurrence, and this occurred in the buccal surface of the cheek more than 6 years after the initial lesion in the face was treated. At present, September, 1936, this patient shows bilateral cervical metastases, although neither his face nor his mouth shows any sign of the large, ulcerating carcinoma that was present before radiation. He also shows extension to the jaw bone.

[1] A "follow-up" and tumor clinic was initiated November 27, 1936, at the Central Division of the Montreal General Hospital.

TABLE VI.—THE MONTREAL GENERAL HOSPITAL. 94 CASES, NOVEMBER, 1929, TO NOVEMBER, 1934.

| Methods of treatment | Patients treated | | | At end of 5 years | | Percentage of |
|---|---|---|---|---|---|---|
| | Total | Traced | Unknown | Alive | Dead | Traced: Alive and well |
| Radium alone | 43 | 30 | 13 | 13 | 17 | 43.3 |
| Radium and surgery | 28 | 20 | 8 | 13 | 7 | 65.0 |
| Radium, surgery and x-ray therapy | 18 | 14 | 4 | 6 | 8 | 42.8 |
| Radium and x-ray therapy | 5 | 4 | 1 | 0 | 4 | 0.0 |
| Total | 94 | 68 | 26 | 32 | 36 | 47.0 |

TABLE VII.—THE MONTREAL GENERAL HOSPITAL. 94 CASES, NOVEMBER, 1929, TO NOVEMBER, 1934

| Site of disease | Total | Traced | End of 5 yrs. Alive | Dead |
|---|---|---|---|---|
| Face | 16 | 10 | 7 | 3 |
| Lip | 15 | 11 | 8 | 3 |
| Mouth, cheek, palate and tonsil | 17 | 14 | 8 | 6 |
| Tongue | 7 | 5 | 1 | 4 |
| Neck | 7 | 6 | 1 | 5 |
| Breast | 18 | 15 | 5 | 10 |
| Esophagus | 1 | 0 | 0 | 0 |
| Rectum | 6 | 4 | 1 | 3 |
| Scalp | 1 | 1 | 1 | 0 |
| Elsewhere | 6 | 2 | 0 | 2 |
| Total | 94 | 68 | 32 | 36 |

It has not been thought feasible, nor even desirable, in our hospital to put all tumor cases under the care of a very small group of men, as is done in many tumor clinics. Instead, we have developed in each department, one or more men who have been especially trained in the diagnosis and treatment of cases which fall into this particular field. The otolaryngologist sees all malignant cases in his specialty, and in this department a special weekly follow-up clinic is held in the outpatient department, at which the chief of the department, the x-ray representative treating cancer cases, and the assistant otolaryngologist, who is responsible for treating these cases, are present.

A certain number of our surgical staff rotate every 3 months from the central to the western division, and the necessities of treatment for pub-

lic patients demand that we have available at each division surgeons trained in the use of radium. As a matter of convenience, however, nearly all public cases requiring radium are treated at the central site.

This method has been adopted to meet our own particular needs at the Montreal General Hospital, and, while not worthy of the name of tumor clinic, it may be of value to general hospitals where no tumor clinic exists. The system is far from perfect, but it does answer fairly well the demands of a general hospital with a large staff who have to care for public and private patients in a university teaching center.

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# CANCER CLINIC IN A UNIVERSITY HOSPITAL

OWEN H. WANGENSTEEN, M.D., F.A.C.S., Minneapolis, Minnesota

A UNIVERSITY medical school possessing a well appointed hospital and an adequate staff, which values the importance of irradiation in the treatment of malignancy, should be the proper setting for a cancer clinic. If, at the same time, in the community of teachers, scholars, and investigators of the university are to be found individuals in the biological and physical sciences who interest and concern themselves in the many interphases of the complex cancer problem, a nucleus for a cancer institute is provided.

Cancer involves so many tissues that no one man can become equal master of all the diagnostic and therapeutic agents which must be enlisted in fighting this dread affliction. In its multiple ramifications the therapy of cancer pervades all the recognized surgical, and many of the medical, specialties. The treatment of cancer must of necessity, therefore, be the joint responsibility of a well trained group of medical and surgical specialists. Anyone who professes to be a cancer specialist arrogates to himself a mastery which he does not possess. The staff of a departmentalized hospital into which a knowledge and appreciation of the value of irradiation has been infused is capable of carrying on a well ordered fight against cancer. Individuals who have become particularly "cancer conscious" find it necessary to surround themselves with many men who possess the specialized type of training to which I have referred in order to treat cancer with any degree of success.

The item which is essential in an effective cancer program is that there be an intimate integration of irradiation and surgery—the only agents which to date have proved their worth as dependable remedial measures. Unfortunately, the number of malignancies which do not respond to irradiation exceed those which are radiosensitive. Every contemplative surgeon who daily notes the anxiety and apprehension of patients who submit themselves to operation would concede that when as good results in a given malignancy can be obtained by irradiation as by surgery, the former should be the preferred agent. The larger number of malignancies still constitute the problem of the surgical specialist; the irradiation therapeutist and the surgeon must jointly concern themselves over the radiosensitive neoplasms; both irradiation therapeutist and surgeon must labor to learn what determines sensitivity to radiation in a tumor and strive to make a constantly increasing number of neoplasms amenable to this means of treatment.

The program of a medical school and hospital is concerned essentially with three activities: (1) instruction of students—the only basis on which a medical school can justify its existence; (2) the care of patients—an adequately large group of patients representative of the diseases taught must be available for purposes of satisfactory teaching; (3) extension of the borders of medical knowledge through research and the training of specialists.

In an effective program, these three activities of a medical school should go hand in hand. No department does wholly satisfactory work which neglects any one of them. Authority and responsibility must go together in instruction as in the direction of the affairs of a State. Only he who teaches from knowledge gained through extensive acquaintance with a disease is worth an audition. There is no substitute for experience.

As for the planning of instruction on cancer in a medical curriculum, it is obvious that he who has a ready familiarity with the diagnostic and therapeutic problems of the disease is in a favored posi-

From the Department of Surgery and the Cancer Institute, University of Minnesota.

Presented in the Panel Discussion on Cancer Clinics, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936

tion to teach its clinical aspects most effectually. The best known methods of cancer recognition and treatment are to be placed before the student. Pathologists, roentgenologists, surgeons, and irradiation therapeutists are all essential for an effective cancer teaching program. Knowledge of concepts of malignancy as well as its practical aspects must be set before the student. He must have the opportunity in the laboratory to study the microscopic and the gross anatomy of neoplasms; he should be privileged to audit conferences in which the diagnostic and therapeutic problems of malignancy are discussed by the staff; he must have the opportunity to observe patients with cancer who are being treated in the hospital and to follow them in the out patient clinic.

The established order in a university clinic is the best means of carrying out such a program. Attempts to concentrate the control of cancer cases and the teaching of malignancy in a university clinic in the hands of a few individuals who have become particularly "cancer conscious" is ill advised and runs counter to the best interests of the cancer problem and to effective teaching. It is important, of course, that there be in such an organization individuals who in their own fields of activity breathe the spirit of life and interest into the complex problem of cancer.

The American Society for the Control of Cancer has as its motto the commendable slogan, "Fight cancer with knowledge." With the numerous attacks which are being made upon the cancer problem from many approaches, more luminous light should soon penetrate the mysteries of this baffling enigma. Those of us who are responsible for the care of patients afflicted with this scourge should inform and avail ourselves of the most reliable known means of its recognition and treatment. Not so long ago, at an important cancer meeting, a recognized authority on cancer complained that medical schools had been remiss in the teaching of the early diagnosis of cancer. How fortunate it would be if some one really were skilled in the early recognition of internal malignancies. Physicians with cancer of the stomach come for treatment just as late as do less well informed persons, according to Alvarez.[1] Every year in our clinic a few patients develop under our very eyes malignancies which we are occasionally slow to recognize. How much more encouraging it would be if the fault were ours rather than the limitations of our methods! When I was a boy of 7, my mother died of hemorrhage before the doctor came. For years, I thought, "Had the doctor only come in time!" This child-like trust has been set aside by the years. And as we gather on occasions such as this we must at least admit to ourselves our limitations in recognizing and treating cancer. It is well that we also ask ourselves whether we should face the public with a bolder front than we are justified in doing. Until the fog surrounding the perplexing problem of cancer clears or until the scales are removed from our eyes so that we see better, let us be oblivious of our own interests and employ our best efforts in service to the patient suffering from cancer.

[1]Alvarez, W. C. How early do physicians diagnose cancer of the stomach in themselves? Study of histories of 41 cases. J. Am. M. Ass., 1931, 97:77 (July 11); Abstr., Bull. Am. Soc. Control Cancer, 1931, 13:1.

# FACTORS RELATING TO THE ORGANIZATION AND CONDUCT OF A SPECIAL CANCER INSTITUTE

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THE purpose of this symposium dealing with the special features of 7 different types of cancer organizations is to bring to the front for consideration and discussion, those factors which characterize each type. Some of these features, under slight modification, might be adopted with benefit by all. And it is even possible that there may be some features of the special cancer institute which could be employed by other types of cancer clinics. Unquestionably certain features of the other 6 types have been absorbed for use in our organization. After all, there is a chain of philosophy running through and binding together each variety of cancer clinic. This fundamental philosophy is common to every cancer organization. In brief, it recognizes that cancer is a disease difficult for both diagnosis and treatment; and it is therefore of necessity a *group* problem and responsibility. Every cancer clinic recognizes this principle as basic for good cancer work. The American College of Surgeons has been outstanding in fostering and firmly establishing this principle which has now become widely recognized by the entire medical profession. Even the public comprehends that the treatment of cancer is not a one man job but that it is a problem to be worked over by a *group* which usually consists of the surgeon, the pathologist, the radiologist, and as many more specialists as are indicated by the special technical considerations of that particular case.

The Memorial Hospital in New York City is a special cancer institute or oncologic hospital, which accepts only those cases having some type of neoplastic disease. Such a cancer hospital can exist only where there is a large center of population, or where, as in certain government hospitals, the cancer cases are gathered from a wide geographical area. The Memorial Hospital is a voluntary non-municipal hospital which meets its annual budget of $460,000 by patients' charges, by income from endowments, and by gifts. Its aim is research in the field of etiology, diagnosis, and therapy, as well as the general relief, care, and treatment of the cancer patient. The Memorial Hospital represents specialization in the cancer field, carried out to a very high state of development. Such narrow specialization as here practiced can be pursued only where the volume of clinical material is very large. Our hospital has approximately 5,000 new cases annually, and from this material about 3,500 new cases are selected for admission to the various cancer clinics.

The hospital is located in a city of 7 million population, surrounded within a 30 mile radius by 4½ million, making a total of 11,500,000 population. Within this so called New York metropolitan area (11,500,000 population) there were 13,775 deaths from cancer during the single year 1934. It is generally believed by those informed that the number of deaths for a given period, multiplied by 3.5, equals the number of cancer cases living in that area during that period. By this rule, during 1934 there were living in the metropolitan area, 48,212 cases of cancer.

A recent survey made by the American Society for the Control of Cancer came to the following conclusion: "The present gradual increase in the amount of cancer will probably have ceased by 1960 for the New York metropolitan area and the number of cancer deaths will then be approximately 30,000 a year." This same survey of patients with neoplastic diseases, discharged from 97 voluntary and municipal hospitals in New York City during 1933, revealed that there were 13,398 patients discharged with malignant diseases, and 18,820 with benign tumors, making a total of 32,218.

These figures would indicate that narrow specialization in cancer is perfectly feasible when carried out in the New York metropolitan area, although we admit that such specialization cannot be employed in small communities or small general hospitals.

Within the walls of our hospital we are opposed to any member attempting to be a general cancer specialist. The field is too large and too technical. Any staff member may act as a general tumor consultant to other hospitals in which the cancer volume is not so large. The duties and activities of the individual staff members are confined to definite fields or disease groups. It is our impression that such a special cancer hospital will furnish

Attending Surgeon and Executive Officer of Memorial Hospital.
Presented in the Panel Discussion on Cancer Clinics, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

ample opportunity for a man to make a career for himself by specializing in one of the major forms of cancer. Our aim is to give staff members contact with the general problems involved in the diagnosis and treatment of every form of cancer, but they are encouraged to specialize in only one. This distinct narrowing of the activities of our staff members may seem too restricted to some.

It is obvious that the special instrumentation required in the diagnosis and treatment of laryngeal, bladder, esophageal, and bronchogenic cancer is beyond the capacity of any surgeon to master. And it is likewise equally impossible for any radiologist to meet competently the special problems of cancerous diseases tucked away in the body orifices. In order to learn the effect of treatment and the indications for more therapy, it becomes necessary to view the neoplasm periodically. Few radiologists are trained to look, for example, at laryngeal neoplasms. Therefore, it has seemed wiser to us to make each separate clinical department of our hospital fully responsible for the diagnosis and for the exact carrying out of all treatment details. The latter may involve the use of technical instrumentation, the employment of surgical procedures, a knowledge of radium with its insertion in proper amounts into tissues, as well as capacity to write the exact prescription for radium packs or x-ray therapy. In other words, competency in surgery can no longer be considered sufficient equipment to constitute a cancer specialist. Today his equipment must *also* include a knowledge of tumor pathology, a speaking acquaintance with laboratory and clinical research, and a practical foundation in all forms of radiation, including the use of radium, low voltage, high voltage, and super voltage x-ray therapy.

Such a comprehensive scheme as the above will insure us that the tumor when treated received exactly what was wanted and what the surgeon ordered. In certain cancer clinics there has been too loose a connection between the therapy ordered and that actually delivered. In some of our departments, the patient is taken to the x-ray department, placed on the x-ray treatment table, "set-up" for treatment, the x-ray tube focused or aimed accurately at the tumor, and every technical procedure carried out by a member of the surgical staff, except the turning on of the switch and the actual delivery of the treatment. Such ideal co-operation between the x-ray department and the other clinical departments will be a long step forward in cancer therapy. This means that surgeons will have to learn more than surgery if they are to treat cancer. This disease rightfully belongs in the hands of the surgeon. Several of the members of our surgical staff have been studying the physics and principles of radiation and have been successful in passing the examinations held by the National Board of Radiology. This we believe to be the general trend in the specialty of cancer.

A general hospital is usually divided into two or three surgical divisions, each division taking all types of surgical cases on its receiving day. Even in some special cancer institutes, such as the London (Free) Cancer Hospital, each surgical division takes all types of cancer cases on its respective receiving day. The Memorial Hospital has a different system. There is no hospital in the world with which I am familiar which has this unique division of the clinical material. Our services are divided on anatomical or disease group lines. There are 9 such clinical services, each with its own staff, namely: (1) head and neck; (2) breast; (3) gynecology; (4) genito-urinary; (5) medical; (6) mixed tumor; (7) rectal; (8) bone tumor; and (9) gastric. Chart 1 gives a schematic representation of the clinical, laboratory, and research organization.

The hospital has a director who is responsible to the medical board and to the board of trustees for the proper laying out of and pursuit of the research problems, as well as for the general care of the clinical material. As the director is a pathologist by training, he delegates the latter function to the executive officer of the Medical Board; he, in addition to his other duties, is held responsible for the general smooth co-ordination of the various services and the clinical departments as well as for the resident surgeon and 6 assistant resident surgeons.

The director is one to whom both research workers and clinicians turn for guidance and stimulation in their problems. He gives the general tone to the institution. Dr. James Ewing has occupied this position for the past 23 years; he is on a full time basis.

The clinicians are not on a full time basis. The full time system is an expensive luxury, and even if it were completely satisfactory for clinicians, which many doubt, there would be but few hospitals which could afford to pay for a staff of full time clinicians. However, the clinicians are so interested in their problems that a great deal of their day is spent at the hospital. It has been frequently remarked by visiting surgeons that they wonder when the clinicians have time to make their living.

Our aim is to have every new patient seen not only by the admitting or examining department,

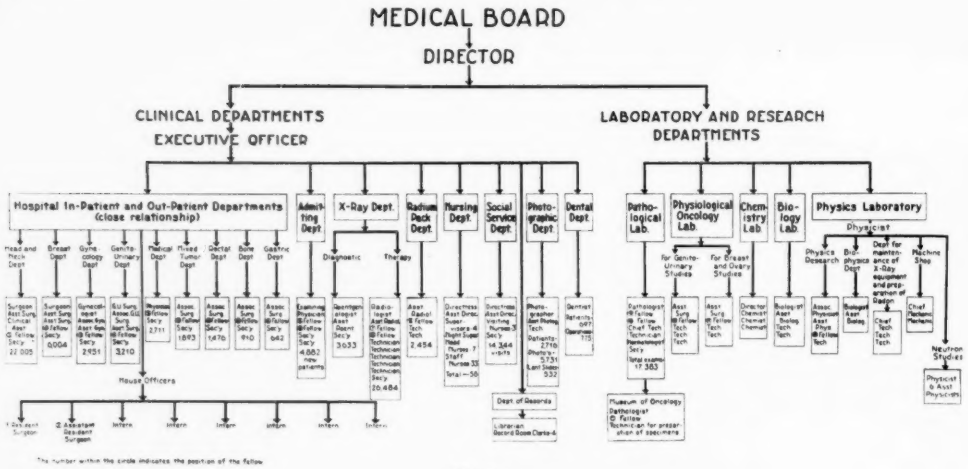


Chart 1.

but also by a member of the special service to which he may belong, on the same day that he applies to the hospital. This obviates delay in giving proper advice, in commencing the therapy, and in allaying fear.

It is of great advantage to the patient to have the visiting surgeons easily accessible because consultation then becomes an easy matter. We recognize the frequency of consultations between the heads of services, pathologist, radiologist, internist, and at times even the physicist, as fundamental for the best type of cancer service. Frequency of consultation is encouraged.

The surgeon in charge of the service, together with his associates and assistants, are on duty during the entire year and there is no rotation of services. Throughout the history of our institution, an increase in volume of cases of a particular type has been followed by the creation of a new service to meet that demand. Recently the advisability has been considered of forming two new services, namely, one for brain and spinal cord tumors and one for tumors of the integument. As yet these have not been created.

Possibly the best method of illustrating the work of a single service would be to consider that of the breast service with which I am most familiar. The other 8 services vary somewhat, but in general they function similarly.

Although many details of the breast department will not be here considered, the major activities consist of the following:

1. The examination of new patients, outlining their course of investigation, diagnosis, and therapy. This takes place daily from 11 to 1 o'clock. During 1935 there were 628 new breast patients examined and referred to the breast service.

2. The follow-up clinic takes place each Monday morning from 9 until 12:30 o'clock. This clinic is conducted by myself, two assistant surgeons, and one research fellow, as well as the assistant resident on the breast service. Four nurses make possible its smooth functioning. Ten women patients at a time are disrobed and sent into the rooms to be seen by the examining surgeons, who in turn dictate their findings to two secretaries. Roentgenographs are ordered, radium or x-ray treatments outlined, patients admitted to the hospital wards for operation, or the proper disposition made for convalescent care or for terminal care in co-operation with the social service department.

This follow-up clinic is attended by the Cornell medical students and by visiting physicians. During the morning, we examine approximately 130 breast cases; there were 6,004 such follow-up visits during 1935.

3. Operations on the breast service take place on Monday, Wednesday, and Friday. There were 402 operations during 1935.

4. On Tuesday and Friday afternoons the routine aspiration biopsies take place. In every new case this procedure is carried out so that the case will have some value in future studies. It may be of interest to state here that the research fellows become very expert in obtaining biopsy material by the needle method. Each fellow has this experience for a period of 3 months, during which

time careful record is made of the successes and failures to obtain cancerous material. The successes run very high. The last two fellows reported 96.1 and 95 per cent of successes. This simple procedure therefore compares favorably in success with the other forms of biopsy.

5. The breast cases are receiving x-ray and radium therapy from 9 until 5 o'clock daily. During 1935, 5,397 x-ray treatments and 989 radium pack treatments were delivered to breast cases.

Such a large number of breast cases seen by the same group of physicians, year in and year out, gives an unusual experience and competency. The same condition exists with the surgeons in each of the other services.

Another feature of our hospital which we consider important is the admitting or examining department. It consists of one physician and two research fellows who see every new patient. The average is 18 new patients each working day. After the history has been taken and the examination dictated, the patient with his chart is taken the same morning to the proper service for further study, outline of therapy, etc.

The admitting department keeps careful record of any case offering difficult diagnosis and, during the establishment of the diagnosis through the proper department, the individual physician follows the progress of the case. By thus recording the cases and following them through to finality in diagnosis, the physician becomes a tumor diagnostician of ability.

There is a fund which pays a salary to each of 11 fellows. These fellows are on a full time basis. They are usually of a high order. They have already had their interneship in surgery, including a houseship, before acceptance. They remain with us for a period of 3 years, during which time they study diagnosis, surgical procedures, tumor pathology, the physics and applications of radiation, and the general care of the cancer patient. By the end of 3 years they are usually exceptionally well grounded with a wide experience in cancer work. Incidentally during these 3 years of their training, the permanent staff of the hospital receives much work and stimulation from them. We consider our fellowships to be one of the most valuable features of our institution.

The fourth year students of the Cornell Medical school come to the Memorial Hospital during their elective periods. A formal course is given which includes a study of new patients, a study of the gross and microscopic pathological material, lectures, and demonstrations. The course is popular with them and is well attended.

An open weekly conference is held on Thursday morning from 11 to 1 o'clock to which visiting doctors are welcome. At this conference about 12 to 15 new cases are presented illustrating interesting points in diagnosis and treatment. Cases undergoing treatment are sometimes presented to demonstrate the results of different types of treatment. The conference is conducted by the head of the admitting department and has maintained interest for many years as demonstrated by an average attendance of about 75 physicians.

The staff conference is held once a month as prescribed by the American College of Surgeons. It is attended only by staff members and is conducted by the executive officer. At this meeting the staff indulges in a frank discussion. It is here they may openly criticize the choice of method, technique, or results of treatment. Infections, deaths, and autopsy records are reviewed. Special problems are here considered. Short reports are presented on departmental work.

Many phases of the work of a special cancer hospital have been omitted for lack of space, but the important characteristics have been reviewed.

# THE STATE AIDED CANCER CLINIC

JOHN H. LAMBERT, M.D., F.A.C.S., Lowell, Massachusetts

IN 1926 the Massachusetts cancer program which includes research, educational work, hospitals, and free clinics, was inaugurated by an act of the legislature, and in 1927 the Lowell Cancer Clinic, one of the first in Massachusetts, was organized under the auspices of the State Department of Health. I am taking the Lowell Cancer Clinic as an example because for a long time it was considered by the State Department of Health a model clinic for a city of about 100,000 population, such as Lowell is. While not all clinics in the state are modeled after it, this clinic is a fair sample of state aided clinics for cities outside of metropolitan Boston. In Boston the state aided clinics are run under the auspices of certain of the larger hospitals and are manned by their own staffs. There are now 8 state aided clinics in Massachusetts.

The Lowell Cancer Clinic is directed by a cancer clinic committee made up of physicians appointed by the Middlesex North District Medical Society. Since there are 3 Class A Hospitals of nearly the same size in Lowell, these hospitals all were represented in this original committee. In the formation of the original staff for the clinic, 2 surgeons and a medical man were named to represent each hospital and the services were so arranged that each group took 4 months each. Since the inception of the clinic there have been some changes in the staff by reason of resignation and death, but the same system has always been retained of keeping a group of 3 doctors whenever possible for filling each service. When the clinic was started, specialists in eye, ear, nose and throat work, genito-urinary work, roentgenology, radiology, pathology, and dentistry were also appointed as consultants, and arrangements were made for referring cases, when necessary, to the skin specialist who is consultant to the Lowell General Hospital. Some of the state aided clinics are run by a small group of men and are supervised or assisted by a specialist from Boston who is paid by the State Department of Health. Our own clinic is run entirely by local men whose services are given gratis; the social worker and the clerical assistant are paid by the state. The state aided clinics which do not have a permanent pathologist may obtain prompt examination of specimens by sending them to the State Department of Health or by requesting that a pathologist employed by the State Department be sent, at different times, to these clinics.

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By arrangement with the hospital authorities, our clinic has been held in the Out-Patient Department of the Lowell General Hospital once a week, at 10 a.m. on Friday. The department of the hospital where the Clinic is held contains a considerable number of well lighted and heated examining rooms with facilities for table, bed, and couch examinations.

First, the patient's history is taken, usually by an experienced, volunteer worker, and the patient is made ready in one of the rooms by a nurse. The history is then read by one of the group of physicians, and further details are obtained if necessary. The patient is next examined by the entire group with a nurse in attendance. The case is then discussed in a separate room and each member gives his opinion independently; the discussion is carried on until an agreement is reached as to the diagnosis and the form of treatment advised. This is then dictated to the regular clerk of the clinic, in the presence of the clinic's social worker who carries out, as far as possible, the directions of the examining group. Any case requiring further investigation by a specialist is referred at once to one of the consulting specialists; the pathologist, radiologist, and roentgenologist are usually in the hospital and easily called in if it is considered advisable. If necessary the patient is admitted to the hospital for biopsy or other methods of diagnosis before his treatment is recommended.

The disposition of the patient is made according to his financial situation, his wishes, and the equipment of the institution to which he desires to go: all the patients referred by physicians are referred back with diagnoses and recommendations as to treatment. Cases not referred by a physician are sent to whatever hospital or physician they desire, provided that hospital or physician is properly equipped for the necessary treatment. The social worker then arranges for such a patient's admission to the desired institution, or for treatment with the physician chosen.

The so called chief of the clinic, who is the chairman of the cancer clinic staff, has endeav-

ored to work with each group in turn for a part of the time in order to co-ordinate the methods throughout the various services. The staff holds conferences at irregular intervals to consider and discuss various problems arising in the clinic. The State Department of Health now requires that there be 4 teaching clinics a year to which either groups of physicians, or all the physicians of the locality, are invited with the hope that more of them will become increasingly interested and more proficient in the diagnosis and treatment of cancer. It has been the custom until recently for the State Department of Health to hold at least one clinic a year in Boston, or some other city, for the benefit of the staffs of the various clinics in the state. These have generally proved to be of considerable value to those who attended. There also has been held annually a meeting of the so called chiefs of the clinics with the commissioner of public health and the director of adult hygiene to discuss the cancer program and activities of the various clinics. Physicians who have referred patients and those who are interested have always been welcome to attend our weekly clinics, but no special clinics are arranged for their particular benefit.

When our clinic was first started, there was some feeling of suspicion among the physicians of the community regarding it, and the majority of the patients came of their own volition, but as time has gone on, many more patients are being referred by doctors than in the past.

Recently the clinic staff has been re-organized; its numbers have been increased and the services divided to make each service 2 months instead of 4. Under this re-organization, each group includes one of the older men who has had the most experience, and two younger men who have had less experience, in the cancer clinic. In this way the group idea of examination is carried out and at the same time a larger and younger group of men is being interested in the work and trained to carry it on in the years to come.

While in some localities many cancer patients are referred to the state cancer hospital in Pondville for treatment, the present trend of the State Department is to have patients treated in their own localities provided they can receive the facilities that would be obtained in the state hospital. From our own clinic, most of the cases are cared for in our own hospitals and by local surgeons and specialists, since we have the necessary facilities, with the exception of a radium emanation plant. (Radon implants have to be purchased either by the patient or some welfare organization. The State Department has never yet seen fit to supply this facility to institutions outside the state hospital and Boston.)

At the beginning of the cancer program a lay committee was formed in each community to spread cancer education to various groups of the laity. This activity waned for a few years but is now again being pushed forward with considerable vigor by the State Department. This is something of a double-edged sword: it helps to educate the public to become cancer conscious, but in so doing it spreads considerable fear in the minds of a great many people. But perhaps the greater good to the greater number is accomplished by this educational program.

# A CANCER CLINIC IN A PRIVATE HOSPITAL

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I HAVE been requested to cover the essential features in the organization and conduct of a cancer clinic in a private hospital.

In 1928 a group of 5 physicians on the staff of the Hollywood Hospital formed a malignancy committee. This hospital, of about 275 beds, is precisely in the same financial and economic position as many hundreds of private hospitals throughout the United States and Canada. No funds were available, either from the hospital or from private sources, as is true in the majority of private hospitals without endowment. It has been considered essential from the start that this malignancy committee should not be a burden, financial or otherwise, to the hospital.

Patients in free clinics and in charity hospitals have had the advantage of study by specialist's groups for many years; private patients, however, are not always so privileged. Because of inadequate facilities in training as well as scarcity of cases, the number of cancer patients seen by the average physician each year being usually not over five, physicians and surgeons individually have little opportunity to become proficient in the diagnosis and treatment of malignancy in the early stage. Avoidable delay time throughout our country, before proper treatment is instituted in the average malignancy, is 7½ months. If the physician is able to obtain qualified consultation and group diagnosis with no loss of time or money to himself or to his patient, this avoidable delay may be reduced appreciably. Group examination and opinions are also more readily sought by the physician if these clinics are available.

The private patient is usually well impressed by a properly done group examination. He is also more willing to accept the situation as it is found and is more ready to undergo prompt treatment. After diagnosis is made, treatment must not only be prompt but adequate. A little treatment because a lesion *may* be cancer is unjustifiable. The original treatment must be carefully planned and then meticulously followed; secondary treatment after failure of the primary treatment is rarely successful.

The personnel of the malignancy committee of the Hollywood Hospital has changed but little since its inception, although the by-laws provide for the appointment of the committee annually. We feel that this committee should be more or less permanent instead of subject to the whims of a board of directors. The services of physicians who have spent the time and effort to acquire knowledge of the diagnosis and management of cancer should be retained for the good of the hospital and the patient. The members consist of a general surgeon, a gynecologist, an internist, a pathologist, and a radiologist. The committee elects its own officers. The record nurse and malignancy interne are appointed by the hospital, as also are the consulting staff, composed of a proctologist, oculist and aurist, dermatologist, and urologist. The 5 regular members are required to be present at each stated meeting unless excused by the chairman; the consultants are not required to attend the regular weekly meetings but are requested to examine patients who are referred to them and to report their findings in person or in writing at the next weekly meeting.

Patients may be referred by any regular physician whether or not he is a member of the Hollywood Hospital staff. Our records show that 75 per cent of the patients have been referred by the hospital staff members, 23 per cent by outside physicians and 2 per cent by some former patient. Physicians from some 20 cities and towns surrounding Los Angeles avail themselves regularly of consultation with our committee. Patients on their first visit are handed a slip of paper by the secretary asking for donations to defer necessary expenses, including printing, stationery, photography, etc.; these donations average $2 per patient.

The history is taken on the regular malignancy form by the interne and is read by the chairman in the committee room, while the patient is prepared for examination in an adjacent room. After examination by all members of the committee, the case is immediately discussed in the committee room. Special laboratory work, x-ray, or other examinations, if desired, are requested of the referring physician. As a rule the physician will direct that biopsies and other examinations be done by the committee.

After full discussion of the case and completion of diagnosis, the committee jointly arrives at the most appropriate treatment. This method lends

Presented in the Panel Discussion on Cancer Clinics, before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

TABLE I.—HOLLYWOOD HOSPITAL MALIGNANCY COMMITTEE STATISTICS 1-1-29—7-1-36

| Year | New cases | Patient visits |
|---|---|---|
| 1929 | 108 | 157 |
| 1930 | 110 | 193 |
| 1931 | 127 | 236 |
| 1932 | 162 | 401 |
| 1933 | 225 | 530 |
| 1934 | 237 | 459 |
| 1935 | 202 | 331 |
| 1936—to July 1st | 136 | 189 |
| Total | 1307 | 2496 |

TABLE II

| | |
|---|---|
| Number of patients referred by doctors on Hollywood Hospital staff | 988 |
| Number of patients referred by other doctors | 222 |
| Number of patients not referred by any doctor | 97 |
| 1210 cases referred by 281 physicians. | |
| 28 physicians have referred from 10-55 cases apiece. | |
| Number of committee meetings—January 1, 1929—July 1, 1936 | 383 |
| Number of hours consumed in meetings | 852 |
| Number of letters written to physicians | 1,460 |
| Number of x-ray pictures taken of breast cases for diagnosis | 500 |
| Number of papers on cancer read outside hospital | 17 |
| Number of papers on cancer read before Hollywood Hospital staff | 22 |
| Cancer clinics held before Hollywood Hospital staff | 5 |
| Delegates sent to 5 annual meetings of the American College of Surgeons and to 4 California State meetings. | |

definite individuality to both diagnosis and treatment of each case.

The chairman, after each weekly meeting, dictates a letter to the referring physician and no information whatever is given to the patient, either verbally or in writing. The patient is directed to see his or her physician in 2 days. Letters to physicians are descriptive of the lesions found, definite attempts being made to give a concrete diagnosis, and of the committee's suggestion as to treatment.

Records of all cases are filed, together with the follow-up. These are available, for statistical purposes, to the committee and to the patients' physicians. Patients entering the hospital after examination by the committee have copies of the consultation letters attached to their charts on admission. Case reports of all operations and treatments are also, on completion, transmitted from the hospital records to the malignancy files.

If a physician, after consultation, grossly disregards the opinion of the committee, this fact is analyzed by the surgical committee of the hospital and appropriate action is sometimes found advisable. The physician and one or more members of the malignancy committee may be requested to meet with the surgical committee in

TABLE III.—COMPILATION TOTAL CASES—JANUARY 1, 1928—JULY 1, 1936

| Type of case | Total No. | Malignant | Non-malignant |
|---|---|---|---|
| Breast | 357 | 153 | 204 |
| Cervix | 172 | 82 | 90 |
| Uterus | 78 | 21 | 57 |
| Vagina | 14 | 3 | 11 |
| Vulva | 8 | 4 | 4 |
| Pelvis | 35 | 16 | 19 |
| Rectum | 50 | 35 | 15 |
| Colon | 11 | 7 | 4 |
| Stomach | 19 | 13 | 6 |
| Œsophagus | 3 | 2 | 1 |
| Liver | 6 | 5 | 1 |
| Lung | 9 | 5 | 4 |
| Mediastinum | 4 | 4 | 0 |
| Pancreas | 6 | 6 | 0 |
| Genito-urinary | 37 | 16 | 21 |
| Bone | 21 | 9 | 12 |
| Skin | 34 | 14 | 20 |
| Hemangioma | 16 | 0 | 16 |

TABLE IV

| Type of case | Total No. | Malignant | Non-malignant |
|---|---|---|---|
| Ear | 11 | 7 | 4 |
| Eyelid | 14 | 9 | 5 |
| Face | 90 | 59 | 31 |
| Jaw | 9 | 7 | 2 |
| Lip | 64 | 28 | 36 |
| Nose | 63 | 27 | 36 |
| Mouth | 41 | 15 | 26 |
| Throat | 13 | 9 | 4 |
| Tongue | 52 | 15 | 37 |
| Scalp | 6 | 2 | 4 |
| Neck | 33 | 17 | 16 |
| Parotid | 6 | 4 | 2 |
| Branchial cleft | 1 | 1 | 0 |
| Thyroid | 3 | 0 | 3 |
| Melanosis | 4 | 4 | .. |
| Melanosarcomatosis | 2 | 2 | .. |
| Carcinomatosis | 6 | 6 | .. |
| Sarcomatosis | 7 | 7 | .. |
| Miscellaneous | 103 | 10 | 93 |
| Total | 1,408 | 624 | 781 |

regard to unnecessary or inefficient treatment in certain cases.

When the committee has had an unusually difficult case, data, including slides, films, etc., and descriptive letters are sent to certain cancer centers for advice. As mentioned in a previous paper, the staff of the Memorial Hospital in New York has been most generous in assisting our committee with many complex cases.

We feel that the cancer clinic in a private hospital is of great importance to the physicians of the community, is instructive to hospital internes, and is helpful to the cancer patient. Physicians referring patients or visiting the clinic are, of necessity, more capable, and better able to recognize early cancer, than is the average practitioner. Reference of malignancy cases to the committee is purely voluntary on the part of the

staff. On the whole the response of the Hollywood Hospital staff has been more than satisfactory, as shown by the number of patients referred. The number of visitors to the meetings averages from 5 to 10.

There are some physicians who, after a diagnosis of malignancy is made, wish to refer their patient to the committee for recommended treatment. These patients are accepted and treated as malignancy committee cases, and an appropriate fee is charged to cover necessary hospital expense, and money remaining being credited to the committee funds. Services rendered by the hospital, as stated above, have apparently repaid the hospital many times, in that many of the patients are hospitalized for the treatments suggested by the committee. Therefore, the administrative departments of private hospitals should assume an optimistic attitude with regard to recompensation for gratuitous services rendered by their full time pathological and x-ray departments in committee work.

Tables I to IV show the statistics of this committee.

# OPHTHALMOLOGY AND OTOLARYNGOLOGY

## CLINICAL CONSIDERATIONS OF MELANOTIC NEOPLASMS OF THE EYE AND ORBIT

WILLIAM L. BENEDICT, M.D., Rochester, Minnesota

THE clinical significance of certain abnormal, melanin-bearing tissues about the eye can be determined in most instances only by microscopic examination. Although it is well known that many of the pigmented areas of the skin and mucous membrane of the eyelids remain unchanged in size or color for many years, and that slowly growing verrucas frequently found along the margins of the lids are only benign tumors, usually of ectodermal origin, the probability that such bodies, even those of long standing, may take on malignant characteristics, grow rapidly and metastasize generally throughout the body makes it difficult to determine in all instances whether it is safe to let them alone or to attempt to remove them.

Melanin is believed to be of hematogenous origin and is deposited in chromatophores of the skin and various other tissues and organs of the body. It is found in varying amounts in otherwise normal tissue, in the skin, iris, and choroid, where slate-colored areas are referred to as "benign melanomas." The depth of pigmentation is sometimes taken as an indication of the rate of growth of a tumor or as a measure of its degeneration, but many fallacies appear in such consideration. Pigmentation may be attributable to melanin in or between chromatophores or to melanin mixed with blood pigment from hemorrhages or from spaces containing stagnant blood. A special test for melanin, the "dopa" reaction of Bloch, gives much information but does not answer all questions regarding the origin or the significance of the pigment. A primary tumor may be heavily pigmented, a recurrent tumor only lightly so, and the metastatic growths may contain little or no pigment. As pigment is not an integral part of the tumor but only a secondary invader, the depth of pigmentation may indicate the age or relative rate of growth.

From the Section on Ophthalmology, The Mayo Clinic.
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The anatomical situation of a melanoma about the lids and conjunctiva may be regarded as of some significance. The skin near the margins of the lids and about the canthi contains patches of pigment, sometimes as senile changes, sometimes as verrucas, but such patches so seldom become malignant that they are commonly regarded as innocent. Small areas of pigmented conjunctiva are frequently found in the caruncle and in the bulbar conjunctiva near the cornea, particularly in brunettes, and are regarded as harmless unless they are associated with an abnormal growth or are uncommonly vascular. In the palpebral conjunctiva, a benign melanoma is seldom seen, but when a melanoma does occur in this region it is almost always highly malignant.

Within the eyeball, benign melanomas are found in the iris, ciliary body, and choroid. The uveal tract is normally pigmented in proportion to the pigment of the skin; it is dark if persons are dark skinned and much lighter if they are light skinned. In albinos, little or no pigment may be visible in the fundus when examination is made with the ophthalmoscope. The structure of the heaps of pigment on the surface of the iris, when studied with the biomicroscope and slit-lamp, may disclose whether they are malignant or abnormal tissue. In no other part of the uveal tract can such areas be examined to such a satisfactory extent. Tumors of the choroid are found in blind eyes which have been enucleated for relief of pain or some other symptom and in which tumor was not suspected, or, if suspected, could not be seen because of obstruction within the pupil or cloudiness of the media. Small, melanotic tumors of the choroid, however, are frequently diagnosed, not principally because of the pigment they bear but because of their relative frequency among all types of tumor found within the eyeball. In one case of this series the eye of a child 4 years of age was removed because of a tumor diagnosed by inspection as a retinoblastoma. Examination by

TABLE I.—MALIGNANT MELANOTIC TUMORS OF THE CONJUNCTIVA; DISTRIBUTION BY AGE AND SEX.

| Decade of life | Palpebral conjunctiva, cases | | Bulbar conjunctiva, cases | | Total |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| 3 | | | 2 | 2 | 4 |
| 4 | 1 | | | | 1 |
| 5 | 1 | | 5 | | 6 |
| 6 | 1 | | 1 | | 2 |
| 7 | | | | | |
| 8 | | | | 1 | 1 |
| Total | 3 | | 8 | 3 | 14 |

a pathologist showed it to be a malignant melanoma. De Lapersonne, in 1903, reported a similar case.

In ophthalmic literature malignant melanotic tumors of the uveal tract are most commonly referred to as "melanosarcomas." In recent years considerable doubt has been thrown on the mesodermal origin of such growths and much evidence has been produced to show that they are ectodermal in origin. In one case of the series with which this paper is mainly concerned, a woman 19 years of age suffered loss of vision of an eye through injury years before the eye was removed in 1923 for cosmetic reasons. On section of the globe a melanoma was found. Less than 3 years later, generalized metastasis occurred throughout the skin of the face, trunk, and arms, and in the internal organs. Biopsy from the skin of the groin showed carcinomatosis, grade 4 (Broders), without pigment. We have been unable to obtain further information about this woman, but the inference that the generalized carcinosis came from the eye is justified on clinical grounds.

The pathological characteristics of melanotic tumors have been described by various authors as a means of determining the germinal layer from which they originated. Others have attempted to classify them as to the degree of malignancy. Callender, in 1931, described 4 main types of primary malignant neoplasm of the uveal tract. They are: (1) the spindle cell type, with subtypes A and B, (2) the fascicular type, (3) the epithelioid type, and (4) the mixed type. Callender and Wilder, in 1935, described a method of staining sections with silver salts, by which means further information regarding malignancy can be gained by correlation with clinical observation.

Terry stated, "It is preferable to avoid any name indicative of origin from a specific germinal layer. A name should also indicate some relation to melanotic pigment, since there can be little doubt that every single one of these tumors does have a tendency to produce melanin. . . . The term 'malignant melanoma' fits these qualifications better than any other name that has been applied to these tumors." Broders, however, prefers to call them melano-epitheliomas, and that classification is followed at the Mayo clinic.

This report is concerned with a series of 138 cases of melano-epithelioma of the eye, eyelids, and orbit, encountered at the Mayo clinic in the period from June, 1917, to July, 1936, in which the diagnosis was verified by pathological examination. In this series there are 108 melanotic tumors of the uveal tract, 15 of the eyelids and caruncle, 14 of the conjunctiva, and one of the orbit.

Of the series of 14 malignant tumors of the conjunctiva, 11 originated in the bulbar conjunctiva and 3 in the palpebral conjunctiva (Table I). Eight of the 14 occurred when the patients were in the fifth or sixth decade of life. All were treated by excision and in some cases this was followed by irradiation, fulguration, or cauterization. In 2 cases primary melanotic nodules were removed from the eyeball by simple excision elsewhere; recurrences necessitated enucleation. Total exenteration of the orbit was done in one case for primary multiple tumors in the palpebral conjunctiva with no recurrence in 12 years. In but one case was there known to have been a serious local recurrence. The recurrent growth originated on the bulbar conjunctiva, was excised, recurred, and spread to the inner canthus, the lower part of the orbit, and the right nares. In no case was there generalized metastasis.

In the 15 cases of tumor of the eyelids and caruncle, the growths were fairly evenly distributed among patients of the fourth to the eighth decades of life. Males, however, seemed to be more prone to tumors of the lid, for the proportion of males to females was 8:1 (Table II). Tumors of the caruncle were evenly divided between the sexes. In no case of primary tumor of the caruncle was there known generalized metastasis. The outlook was not so favorable for those patients who had tumors of the lids. Six of the 9 patients were known to have locally recurrent growths with extension to the parotid and submaxillary glands.

The largest group of this series was composed of melano-epitheliomas of the uveal tract; of these there were 108 (Table III). Nearly 30 per

TABLE II.—MALIGNANT MELANOTIC TUMORS OF THE EYELIDS AND CARUNCLES; DISTRIBUTION BY AGE AND SEX.

| Decade of life | Eyelids, cases | | | Caruncle, cases | | | Total |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | |
| 4 | 2 | 1 | 3 | | 1 | 1 | 4 |
| 5 | 2 | | 2 | | 1 | 1 | 3 |
| 6 | 2 | | 2 | 1 | 1 | 2 | 4 |
| 7 | | | | 2 | | 2 | 2 |
| 8 | 2 | | 2 | | | | 2 |
| Total | 8 | 1 | 9 | 3 | 3 | 6 | 15 |

cent of them occurred when the patients were in the sixth decade of life; 24 per cent, in the seventh decade; 21 per cent, in the fifth decade; 15 per cent, in the fourth decade; the others afflicted patients who were scattered through the first, second, third, and eighth decades of life. The youngest patient operated on was 4 years of age. A grayish reflex in the pupil had been noted for 2 years.

Symptoms of primary intra-ocular tumors are not such as to lead to a diagnosis of the condition. Disturbance of vision is the most frequent cause for examination of the eye. Detachment of the retina, tuberculosis of the choroid, and exudative choroiditis must be distinguished from tumor, largely by ophthalmoscopic inspection. In many cases, because of cataract, glaucoma, or phthisis bulbi, the eye is in such condition that ophthalmoscopic examination is impossible. Twenty (18.5 per cent) of the patients in this series of 108 cases had an eye removed for relief of congestive glaucoma. While intra-ocular tumors may have been suspected, verification was not possible until after enucleation.

The scope of this paper will not permit a detailed analysis of the malignant melano-epitheliomas of the uveal tract from the viewpoint of malignancy, but it is significant that 26 per cent of the patients in this group, when they first came to the clinic, had recurrences in the orbit or generalized metastasis, or both. Others are known to have had metastasis after a few months to a few years. As some of the persons from whom an eye was removed died of some other cause within 2 or 3 years, a reasonable estimate of probable recurrences or metastasis cannot be made.

The one case of melanotic tumor of the orbit deserves special mention.

TABLE III.—INTRA-OCULAR MELANOTIC TUMORS; IRIS, CILIARY BODY, CHOROID; DISTRIPUTION BY AGE AND SEX.

| Decade of life | Male, cases | | | Female, cases | | | Total |
|---|---|---|---|---|---|---|---|
| | Right eye | Left eye | Total | Right eye | Left eye | Total | |
| 1 | | | | | 1 | 1 | 1 |
| 2 | 1 | 2 | 3 | | | | 3 |
| 3 | | 3 | 3 | 1 | | 1 | 4 |
| 4 | 1 | 6 | 7 | 6 | 4 | 10 | 17 |
| 5 | 7 | 4 | 11 | 4 | 8 | 12 | 23 |
| 6 | 12 | 10 | 22 | 1 | 9 | 10 | 32 |
| 7 | 9 | 5 | 14 | 5 | 7 | 12 | 26 |
| 8 | 1 | 1 | 2 | | | | 2 |
| Total | 31 | 31 | 62 | 17 | 29 | 46 | 108 |

A boy of 15 years had suffered several severe injuries to the head in early childhood, and to these was attributed a mild proptosis of 4 years' standing. Examination revealed discoloration of the conjunctiva, of the right side of the soft and hard palate, and of the mucous membrane of the right nares. A specimen taken for biopsy from the lower part of the conjunctiva was reported to be stained by old blood pigment. A diagnosis of hemangioma was given and ligation of the right carotid artery and its branches was carried out. Proptosis progressed, however, until the cornea was lost and exenteration of the orbit became necessary. All the retrobulbar orbital tissue was intensely pigmented, and near the apex of the orbit degeneration and necrosis had extended to complete softening. There was approximately 10 cubic centimeters of thick material of the color and consistency of tar. The orbit healed in the usual time. The pathological report was that the tissue was deeply pigmented melano-epithelioma. After 9 years the patient is well and there has been no recurrence.

In general it was observed that the tumors which contained the greatest amount of pigment were the least malignant from the standpoint of the presence of mitotic figures and of metastasis, while the most extensive metastatic tumors contained little or no pigment.

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## Discussion

DR. PERCE DE LONG, Philadelphia: Melanotic neoplasm of the eye and orbit still remains a perplexing problem, and as the author asserts, it is difficult to decide clinically when surgical intervention is to be recommended, for in many instances the malignancy can be determined only after microscopic examination.

Dr. Benedict has incorporated a report of 138 clinical cases of "melano-epitheliomas," but he does not venture a recommendation for treatment. Perhaps he feels (as I do) that many of these neoplasms remain benign for an indefinite period, and that no fast rule can be applied.

There are no new conceptions as to the relationship of melanotic neoplasm, but in view of Dr. Benedict's wide experience, a brief discussion as to how he manages these cases would be of infinite value.

From a pathological standpoint, may I say that I do not believe melanin is a product of the blood. Melanin does not give the same reaction as hemoglobins. The dopa reaction is one that differentiates melanin from blood derived pigment. There are many types of melanin, as shown by various biochemists. Some types contain sulphur compound. Other biochemists claim melanin to be a tyrosin or a tryptophan.

Literature is profuse with regard to malignant melanomas. They have been classified (1) as to type of cell and (2) as to the germinal layer from which they have originated. It is difficult to see how the particular shape of a cell could be a direct criterion of the degree of malignancy, for in many instances we find all types of cells in the one neoplasm—round, spindle, fascicular. This merely describes the shape of the cell, the shape depending largely upon the pressure exerted and the line of least resistance.

It is also a difficult matter to determine the germinal laye· from which these cells originate. Whether they are of ectodermal or mesodermal origin has not been definitely determined. I agree with Terry that the name applied to the neoplasm should indicate some relationship to the melanin which it bears, and for this reason I prefer the term "malignant melanoma."

What determines the degree of malignancy? The degree of melanin certainly does not, for it is common to find highly pigmented areas in the same neoplasm with areas containing no melanin. Neither can vascularity be a factor, because many benign tumors are highly vascular and are of slow growth, such as hemangiomas. Can mitosis be a criterion? No, because mitotic figures are not usually found in a rapidly growing neoplasm. However, we do know that mitosis passes in waves and cycles.

Personally, then, I do not know how we can decide the malignancy of these neoplasms. The 138 clinical cases embodied in Dr. Benedict's paper coincide to a surprising degree with the 133 cases collected at the Wills Hospital since 1921.

Dr. Benedict has given us a keen observation of real value when he reports that melanomas which appear in the palpebral conjunctiva are seldom benign, but are usually highly malignant.

# PATHOLOGICAL CONDITIONS AFFECTING THE SALIVARY GLANDS AND FLOOR OF THE MOUTH

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BECAUSE the conditions which affect the salivary glands and floor of the mouth are much more prevalent than would be evident from the comparative paucity of material published on the subject, and because the otolaryngologist is often the first medical advisor sought by the patient, I shall attempt to summarize briefly the more important conditions. It is hoped that recapitulation of the outstanding signs and symptoms of the various conditions and emphasis of the seriousness of many will stimulate perception and observation which will lead to early diagnosis and proper treatment.

There are several possible means of classifying these conditions, among which are: duration, extent of involvement, and pathological diagnosis. But as the only advantage to be gained from any classification is merely facility of handling discussion, they may be divided somewhat arbitrarily into two rough general groups: the acute inflammatory conditions, and those of a somewhat chronic nature. The former category embraces: infection, acute and postoperative; epidemic inflammation (mumps); calculi; foreign bodies, and other obstruction of salivary flow; Ludwig's angina; osteomyelitis of the mandible and extensions from it. The latter group includes: congenital abnormalities; chronic inflammation; tuberculosis; syphilis; ptyalism; pseudohypertrophy (Mikulicz's disease); fistulas; actinomycosis; cysts; neoplasms; and xerostomia.

## INFECTIONS

*Acute.* Acute infections may be caused by irritation due to calculi, foreign bodies, the continual use of atropine, and oral sepsis. Another factor is the withholding of fluids by mouth following operation elsewhere on the body, which produces dehydration and partial or complete obstruction of the salivary ducts. Anthony quotes Charlton as stating that in cases of gastric ulcer treated by oral starvation acute suppurative parotitis develops ten and one-half times more often than in patients allowed fluids by mouth. Anthony also noted that acute infections following operations occur more frequently when respiratory infections are prevalent. The treatment is removal of the source and palliation of the inflammatory signs for relief of the patient.

*Postoperative.* Postoperative infections may occur after any operative procedure upon the body, regardless of location. They are low in incidence but high in actual or potential danger, and accordingly must be recognized. The parotid gland is the one most often involved. The etiology is doubtful, but of the four theories—that the causative factor is hematogenous, ascending (via the salivary ducts), traumatic (by anesthetist), or lymphatic the preponderance of evidence favors the hematogenous and ascending channels (14). Restriction of fluids may be a causative factor here, too. The best treatment is prophylaxis by careful surgical technique, but when such infections do occur, the treatment is palliative.

*Epidemic inflammation (mumps).* Mumps belongs in the fields of contagious and childhood diseases and is too well described in standard textbooks to need more than passing mention here. However, it should be borne in mind that cases have been reported of this type of involvement of other salivary glands than the parotids (11).

*Calculi, foreign bodies, and obstruction of salivary flow.* Many authors, even in recent years, have insisted that salivary calculus is rare, although they simultaneously note reports of over 500 cases of the condition. However, because it has been considered a rarity, little effort has been made to acquaint the practitioner with the signs and symptoms. This is surprising in view of the marked unanimity of description by all authors.

The symptoms may be mild or severe, and they vary with the degree, location, and nature of the obstruction. The mild ones are often overlooked or unheeded because they accompany the early stages of the calculus growth. They are: periodic irritation, inflammation, and discomfort in the region affected (although this may be difficult for the patient to define exactly), and there may be swelling in the sublingual and submandibular regions. Because these mild symptoms may appear and disappear with only temporary distress for the patient, they often exist for some time before he seeks medical attention. It is the severe symptoms which the physician sees most often.

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They are sudden, sharp pain on eating or other stimulation of salivary flow, and swelling which persists, although it may vary in size. Often marked inflammation and suppuration are present, and there may be fever and toxic symptoms if there is pus retention.

Clinical examination usually reveals induration of the tissues beneath the tongue with at times a ridge over the region of the calculus and usually tenderness over the obstruction. Palpation may reveal the location, and there may be swelling and induration of the base of the tongue and the submandibular region.

The etiology of salivary calculi has been discussed at length by many authors, but most clinicians agree in general with Bonnet and also Reisler that the predisposing causes are those which augment the virulence of buccal organisms, that is, defective oral hygiene, general and local disease, salivary stasis, and any cause tending to modify the hydrogen-ion concentration and the constituency of the saliva.

Any gland or duct may be affected, but the most frequent sites are the submandibular gland and Wharton's duct, next in frequency is the sublingual region, and last the parotid. New and Harper found the right submandibular involved twice as often as the left. Males are affected much more often than females, and the condition may occur at any age, but it has a predilection for middle life, although cases have been reported as early as infancy and as late as 70 years of age. Merrill has recently reported calculi in both ducts of the submandibular gland in the same patient.

In the diagnosis, differentiation must be made between calculi and Ludwig's angina, phlegmon, periostitis, tumors, infections, cysts, enlarged lymph nodes, Hodgkin's disease, tuberculosis, lues, and actinomycosis. Ivy and Curtis quote Soederlund as stating that actinomyces were demonstrated in all calculi in his series of 41 cases. But they seem to be alone in that conception, as most other writers on the subject point out the necessity for differentiating the two conditions.

Because their main constituent is calcium in salt combination, calculi may be demonstrated on the roentgenogram. There are various devices of roentgen technique which enhance the visualization. One of these is a film placed in the patient's mouth in the occlusal plane, the tube below the chin, and the rays parallel to the long axis of the teeth. In 1933 Iglauer reported the value of a simple maneuver for increasing the visibility of a salivary calculus on the roentgenogram of a patient in whom its shadow is covered by that of the jaw. The maneuver consisted of the roentgenologist placing his finger in the floor of the patient's mouth and depressing the submandibular gland and duct so that the shadow of the calculus was cast upon the roentgenogram below that of the bone.

Treatment necessarily varies with the stage of the condition. Acute inflammatory symptoms must be treated for palliation by hot mouth irrigations and cold external dressings. When they have subsided, most authors agree that removal of either the stone or the gland is the proper therapeutic measure. However, there are quite a few recorded cases of spontaneous expulsion and also of expulsion following probing the duct for diagnostic purposes. Consequently, a number of years ago, I had made a set of probes of various diameters which I use to dilate the ducts gradually. This gradual progressively increasing dilatation often permits the calculus to follow the probe out, and obviates employing more radical surgical measures.

The surgical procedure, when necessary, is not as a rule an elaborate one. In adults and cooperative children this can be done under local anesthesia and the incision is a simple one which seldom necessitates suturing. The recovery is usually uncomplicated. The postoperative treatment consists of general mouth hygiene. External operation may be necessary in cases of multiple calculi, tumor, or cyst of the gland, or tuberculous infection. The technique of operation depends upon the operator who must avoid injury to the hypoglossal nerve in operations on the submandibular or sublingual glands and the facial nerve in any operative interference in or around the parotid. When the parotid gland is involved, the incision is often an external one, and care must be taken not to injure the facial nerve.

*Obstruction of salivary flow.* There may be obstruction of salivary flow without calculus formation. Foreign bodies, such as toothbrush bristles and hay and wheat straws in rural districts, are occasionally responsible for such conditions. Removal with attention to any accompanying inflammation is the treatment indicated.

*Ludwig's angina.* This infection is a phlegmonous cellulitis which generally is secondary to carious or infected teeth, the specific fevers, scurvy, and similar conditions. The causative factor is a virulent streptococcus; staphylococci and diplococci and Vincent's organisms may also be present. It is disseminated supposedly through the lymph channels and is characterized by a rapidly spreading edema involving the floor of the mouth, submandibular regions, and upper part

of the neck. The glands enlarge and may be destroyed. Then the infection spreads along the connective tissue planes. It runs a very rapid and virulent course, and edema of the glottis is not an infrequent complication. This may necessitate tracheotomy. The involvement often is so extensive as to include the whole neck and extends even to the mediastinum. In that event, the area appears board-like and hard with brawny swelling. The temperature may rise rapidly within moderate limits or at times even reach 105 or 106 degrees F. Points of fluctuation may be present. The prognosis is doubtful because the disease bears a high mortality rate, although death, when it occurs, is usually due to edema of the glottis and pneumonia or to septicemia.

The treatment is essentially surgical, and its goal is the establishment of drainage, maintained freely by rubber tube drains. Local palliative agents, such as antiseptic fomentations, may aid recovery after operation and relieve the patient. It must be kept in mind that poultices or hot fomentations will be of little value in cases of deep infection of the floor of the mouth or neck because of the tendency of infection to follow muscle planes and because of the thick overlying fascia. Surgery should be early and thorough; by this I mean, "Find the pus," as failure to do so exposes the patient to septicemia if not to thrombosis of the large vessels of the neck, and in many cases to edema of the glottis. The patient's general condition must be assiduously guarded, and any indicated measure which will increase resistance must be employed, as for example, convalescent serum as soon as the organism is determined.

*Osteomyelitis of the mandible.* This is included because the floor of the mouth and salivary glands are so frequently involved, and in most cases symptoms of Ludwig's angina are present. Osteomyelitis of the mandible is probably a very common condition, although in 1912, Blair stated that he had seen only one case of acute metastatic osteomyelitis of the jaw bone. Twenty years later, Wilensky reported that statistics showed that of the bones affected by osteomyelitis, the jaws were the eighth in frequency, and that the lower jaw was much more often affected than the upper one. Males are more frequently affected than females; the usual proportion stated is about 3:1. It occurs at all ages, but the condition in children has been differentiated from that in adults. In them it is a secondary disease and occurs sometimes as a result of the acute exanthematous fevers. Wilensky said that the only differentiation which should be made is that there is more spongiosa in the bone of the young, and as long as there is growth there is greater blood and lymph supply. Consequently the younger the subject, the more frequent the occurrence of hematogenous or odontogenous osteomyelitis. In young children, the upper jaw is more often affected than the lower.

The causative factor is odontogenous or traumatic, such as a fall, blow, gunshot wound, or operative manipulation. Operative procedures, including block anesthesia, during which injury to the vessels may occur are responsible for many cases. Suture of wounds which may be infected or failure to drain wounds which may close over a blood clot that already is or may become infected may also be responsible. In osteomyelitis, teeth may be involved even though the roentgenogram appears negative, because the lingual aspect of the tooth is not visible on the film. Obviously, it is impossible to portray that aspect with any of our present methods.

The disease is characterized by swelling, tenderness, pus welling up around the teeth, pain, and necrosis of the bone. Wolfe said that osteomyelitis of the body of the mandible differs from that of the ramus in its clinical appearance and prognosis. He emphasized hypoesthesia of the lip as an important and early diagnostic sign when the body is involved.

Osteomyelitis is important because of the discomfort to the patient and because of its complications. According to Wilensky, the latter may be because of lymphatic drainage, general infection (bacteremia, sepsis, septicemia), or local complications, such as abscesses, ankylosis, phlebitis (rare), meningitis (also rare), cerebral abscess, erysipelas, and tetanus. The last named is probably confused with trismus.

The treatment is generally conceded to be establishment and maintenance of drainage with an interval to permit formation of a sequestrum, then removal of all remaining sequestra, and attention to healing and the end-results. In 1934 Miltner and Wolfe proposed a more radical procedure which they used successfully on 8 cases. It embodied several steps: (1) removal of the necrotic outer plate of the mandible as soon as possible during the early chronic stages, i.e., 21 days after the onset through a wide external approach even before sequestrum formation; (2) removal of teeth over the area of osteomyelitis; (3) exteriorization of the tooth sockets and partial resection of the alveolar process with complete closure of the gum margins to prevent further drainage of the purulent material into the oral cavity; and (4) immobilization of the jaw.

Personally, I prefer a method which embraces the following steps; (1) the establishment and maintenance of drainage either internally or externally at the lowest point for relief of congestion; (2) removal of teeth apparently abscessed or loosened; (3) interval for sequestrum formation; (4) removal of sequestra and attention to healing. I prefer to guard against involucrum formation, and when indicated, I stimulate cell growth by the assistance of x-ray treatment.

### OTHER PATHOLOGICAL CONDITIONS

*Congenital abnormalities.* Congenital abnormalities are various and of wide range in possibility. The range extends all the way from glands which are misplaced (22) or entirely absent (20), either unilaterally or bilaterally, to anomalous locations of duct orifices (9). Occasionally, there is atresia of the ducts (3), or they may be small or double (1). There are reports of congenital salivary fistulas, and of hereditary congenital absence of the salivary glands (1). Blackmer reported a case of congenital absence of the salivary glands with congenital atresia of all lacrimal puncta. In 1930, Tillotson reported finding aberrant salivary gland tissue in the tonsil fossa, and at that time, he was able to find only one other such case on record.

*Chronic inflammation of the salivary glands and ducts.* This may result from any source of persistent irritation, such as acute infection of the salivary glands or ducts, or it may follow chronic intoxication, uremia, narcotics, lead, bismuth, or arsenic administration. A careful history and clinical examination with roentgenography for verification and the necessary laboratory measures should lead to the correct diagnosis. Tenderness, enlargement, and often lessened salivary flow are the clinical signs. Treatment must be directed toward elimination of the cause and relief of the local acute manifestations with the usual alleviating agents and general measures.

*Tuberculosis and syphilis.* These are well defined clinical entities with published material on the etiology, symptomatology, diagnosis, and treatment of each, although both conditions are rare in the salivary glands. In 1914, I reported a case of bilateral parotid gland tuberculosis. At that time there seemed to be only 15 other cases recorded. Since then, I have seen 2 other such cases, and although no extensive study of the literature has been made, it would seem to be still a very rare condition. The recent textbooks either do not mention the condition at all or only very briefly. All of my patients were men, but a superficial survey of the cases reported indicates that the condition is about equally prevalent in either sex and has no particular predilection for any age group.

At this time, mention is made of both syphilis and tuberculosis merely that their potential existence may not be forgotten in the diagnosis of pathological conditions affecting the floor of the mouth and the salivary glands.

*Ptyalism.* This condition is one of excessive secretion from the salivary glands. It is caused by large doses of pilocarpine, potassium iodide and mercury, all varieties of stomatitis except thrush, rabies, and functional nervous diseases. Atropine in small doses to inhibit secretion is the treatment indicated.

*Pseudohypertrophy or Mikulicz's disease.* This is a chronic affection of the salivary and lacrimal glands which, because of its possibly transient character, is often given insufficient weight. Swelling is the only symptom and it is symmetrical, although one side may be enlarged more than the other. It is due to replacement of glandular tissue with lymphatic cells, but the causative factor is not definitely known. Neither is the treatment definitely established, but arsenic and potassium iodide are recommended. Anthony said partial removal should be avoided except where it is warranted to overcome marked disfigurement.

*Fistulas.* Any abscess is likely to produce a breaking down of surrounding tissue with establishment of a drainage channel. The salivary glands are not exempt from such abscesses or the possibly resulting fistulas. Also fistulas may follow acute infections or surgical procedures. Diagnosis by clinical means should be feasible, although injection of iodized oil to show the extent of involvement may prove helpful as a guide to therapy. Eradication of the cause and palliation of the discomfort is the rational treatment. Plastic surgery may be necessary if the condition is of long standing and destruction of the gland has taken place. Figi has reported one such case.

*Actinomycosis.* The differential diagnosis of actinomycosis is, of course, dependent upon demonstration of the actinomyces, but the condition is itself a secondary one, secondary to infection of the mouth, gums, or tonsils. The treatment is primarily surgical, and it embraces incision of the abscesses, establishment and maintenance of drainage, and removal of dead tissue. Supportive medication by potassium iodide in the form of Lugol's solution in ascending doses, and radiation therapy are aids to a cure.

*Cysts.* The most common cysts of the oral cavity are radicular or root cysts, follicular or

dentigerous cysts, and ranulas which are retention cysts. Occasionally, mucoid, multilocular, and dermoid cysts occur. The radicular and dentigerous types are concerned with the teeth and, consequently, this study is concerned with them only in the instances in which they rupture into and pollute the floor of the mouth. The possibility of their occurrence is rather generally borne in mind whenever problems of oral pathology are presented. The only reason for mentioning them here is to recall that they are not the sole possible cause of oral disease.

Multilocular cysts usually occur in young subjects between the ages of 20 and 40 years; more often in females than in males; and more often in the lower than in the upper jaw. The name is descriptive of them, and although they are believed to spring from epithelial rests, they are the least malignant of such growths in the jaws. They do not ordinarily metastasize, but they have a tendency toward malignant degeneration. They must be differentiated from sarcomatous growths. The treatment is extirpation with care to remove all the parts.

Mucoid cysts are retention cysts, but they seldom occur in the floor of the mouth.

Ranula is a retention cyst of the salivary glands in the sublingual region. It derives its name from its resemblance to a frog's belly, and it must be differentiated from salivary gland infections. It occurs at any age, in both sexes, and is not an uncommon disease condition. The diagnosis rests upon the absence of inflammatory symptoms which is characteristic of ranula. The treatment is surgical and requires precision technique. Berger stated that simple evacuation may produce temporary subsidence of the condition which only recurs. He also said that a seton in the form of a wire loop passed through the growth to permit seepage of fluid contents and subsequent retrogressive degeneration is of only doubtful value. He gave the detailed technique for the procedure which he considered yields the best results. This is done under local anesthesia and consists of careful exposure of the cyst sac, excision of the exposed part, careful sponging out of the fluid contents, inversion of the mucous membrane flaps, and suturing of them to the denuded sides of the cyst cavity. This technique in our hands has yielded the best results.

Dermoid cysts are, of course, always congenital, but they often are not noticed until middle life. They are caused by an inclusion of epiderm within the tissues formed from mesoderm and, like dermoid cysts in other locations, may contain hair, teeth, and other materials. They may occur in the midline beneath the skin or between the geniohyoglossal muscles; laterally below the angle of the jaw, and in the submandibular gland itself. Blair, writing in 1912, stated, "Usually as the result of ill-planned attempts at their destruction, the cavity may be an abscess communicating with the mouth or neck by a fistulous tract." One of the most complete articles on the subject was published in 1925 by Colp, and his statements made then are still essentially unchanged. Diagnostically, dermoid cysts must be differentiated from ranulas, sarcomas, lipomas, angiomas, and thyroid tumors or cysts. For this purpose, the following characteristics are useful: Although it occurs rarely, a yellowish color is pathognomonic; on palpation these cysts yield a doughy sensation, they are slow in growing, and unless they are tense they pit on pressure. Pain is unusual unless there is pressure on the lingual nerve. The position of the tongue varies with the location of the cyst. The roentgen examination should demonstrate the presence of solid inclusions if any are present. The treatment is complete extirpation, but the approach and the technique depend upon the operator and the individual case.

Thyroglossal cysts may be found at the base of the tongue, or the swelling may be found in the neck.

*Neoplasms.* The tumors of the salivary glands and floor of the mouth are generally so called "mixed tumors." They are usually considered as being of epithelial origin, although there is still a difference of opinion as to their exact nature and formation. In 1930 Patey analyzed 55 cases from the mouth region, and he found the parotid gland was the one most often involved; the submandibular region, second; the palate, third; the other regions such as the lips, angle of the mouth, face, tongue, and sublingual gland followed. His findings seem typical of the situation. The consensus is that the histological picture is of little help in the prognosis of such tumors, but Martin and Elkin, writing in 1934, agreed with Patey that the more cellular the tumor, the more likely is recurrence. This is true regarding tumors in general as noted by Broders, and especially in eye tumors, as stated by Wilder (personal communication). Patey also found the infiltrating type more difficult to eradicate, and consequently it offered the poorer prognosis. Regardless of the histological findings, there is indubitable agreement that early diagnosis and complete removal followed by irradiation therapy offers the best hope of good end-results, although Martin and Elkin concluded from their series of 24 cases that at best the prognosis is not hopeful.

The benign tumors of this region are usually amenable to total surgical removal. Some of them may become malignant, but if there is a history of long duration, that is unlikely. In any event, complete removal and postoperative irradiation is the proper therapeutic procedure.

*Xerostomia* is a condition characterized by reduction of the amount of saliva, and it is usually associated with severe diabetes. With the etiology in mind, the therapy must necessarily be that of the diabetic condition.

## CONCLUSIONS

A review of the pathological conditions affecting the salivary glands and floor of the mouth brings to mind the following points:

1. These conditions are of importance to the patient and consequently necessitate early correct diagnosis.

2. They are sufficiently frequent in occurrence to require the otolaryngologist to be familiar with them.

3. The salivary region is one which requires proper handling, critical judgment, and technical skill.

4. Therefore the salivary region and its diseases are worthy of further study by the otolaryngologist.

5. Finally, the physician pays too little attention to the patient's teeth and jaws as well as his salivary glands.

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## Discussion

Dr. George B. Wood, Philadelphia: It has been a privilege to listen to Dr. Carmody's paper and it is an honor to be asked to discuss it.

Ludwig's angina usually results from the rupture of apical abscesses of the molar and premolar teeth of the lower jaw, but very occasionally from calculus with infection in Wharton's duct or in the deep prolongation of the submaxillary gland. It originates unilaterally but may spread so rapidly that very early the whole floor of the mouth is involved in the cellulitis. The prognosis is always serious but the streptococcic infections give a high mortality. The clinical appearances which are pathognomonic of this disease are board-like swelling in the floor of the mouth, either bilateral or unilateral, with elevation of the tongue.

The treatment is early incision and drainage of abscesses when they are present, but when there is diffuse phlegmonous cellulitis without pus, a complete and radical opening up of the whole infected area is absolutely necessary. It is frequently possible in the early unilateral stages of the disease to open the abscess through the mucosa of the mouth. Later, and especially in streptococcic infections, when the wider and more drastic opening of the floor of the mouth is called for, I believe that it is best accom-

olished by a transverse incision immediately beneath the chin made as wide as possible without endangering the facial arteries. The further approach to the floor of the mouth is made by cutting through one or both of the geniohyoid muscles. The choice of an anesthetic in operating upon patients with Ludwig's angina is very important; when radical operation is necessary, gas oxygen anesthesia is my choice.

Salivary calculi seldom cause symptoms until they enter the ducts, hence they are seldom diagnosed while still intraglandular, but are by far the most common cause of enlargement and tenderness of the submaxillary glands. The characteristic subjective symptom of obstruction of the salivary duct is increase in pain and in the swelling of the gland during and after eating. The amount of swelling of the gland does not always depend upon the size of the calculi, small calculi causing as much obstruction when located near the caruncula as old large calculi which cause sacculated distention of the duct and thus permit the flow of saliva around the calculus.

I have seen two cases of rupture of Wharton's duct from calculi, in one of which I was able to pass a curette into the gland itself through the opening and excise a large amount of intraglandular stones.

In regard to ranula there seems to be considerable confusion, not as to the clinical appearance, but as to what these cysts really are. It is important to remember that in the adult they never result from occlusion of Wharton's duct. They probably develop from a number of different structures, though clinically they are similar. McFarland lists six different possible origins, though the Blandin-Nuhn glands which have undergone cystic degeneration are probably the most common source of such cysts as these.

Dr. Carmody mentioned tuberculosis of the parotid gland which reminded me of a case from which I removed what I supposed was a tuberculous lymph nodule just below the ear, but on histiological examination it proved to be tuberculosis of the parotid gland. Evidently just the lower tip of the gland, which was the part I removed, was involved because the patient made a complete and permanent recovery. This case was of special interest because the tuberculosis seemed to occur in the lymph nodules which we know are frequently found in the body of the gland and it suggests the possibility of a retrograde lymph current being an important etiological factor in parotid tuberculosis.

# LARYNGECTOMY FOR CANCER OF THE LARYNX

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IN THE past few years deaths from cancer have been steadily increasing until now the mortality rate for this disease has reached second place, a condition certainly alarming. As about 4 per cent of all cancer cases involve the larynx, this subject should be of some interest to most laryngologists.

MacKenty (4) found that 98 per cent of the malignant tumors of the larynx were carcinomas, 1 per cent adenocarcinomas, 1 per cent papillary carcinomas, and 2 per cent basal cell carcinomas.

The type of carcinoma most frequently found in the larynx is the highly malignant squamous cell variety which occurs in 96 per cent of the cases. Most of these patients will die within 1 to 3 years unless the growth is removed by surgical means. In a study of 200 cases by Tucker, 72 per cent were found to have intrinsic cancer, the type which offers a good chance of cure if operated on early in the disease.

The complete early removal of cancer by surgical means still remains the most satisfactory method of treating these cases. The establishment of larger radium institutes, the increasing advance in the development of super x-ray machines, and the improvement in the technique of deep x-ray therapy in the treatment of these lesions may, as time goes on, prove to be successful. But at present, when there seems to be such a wave of overenthusiasm for the use of palliative forms of treatment, it seems timely to sound a note of warning against the too general acceptance of conservative methods of handling malignant disease.

Most patients are reluctant to undergo surgical operations and eagerly grasp an opportunity to take an easier course, frequently at the cost of life. We all know that the time element is important in cancer, and that if the patient is seen early and the growth is completely removed, he has a good chance of being cured. If, on the other hand, removal has been delayed by the use of some of the physical modalities, there is danger of more extensive invasion of the growth, with possible metastasis and lessened chances of recovery; and in most cases such treatment makes the operation more difficult.

Presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

## DIAGNOSIS

In every paper on cancer, no opportunity should be lost to emphasize the great importance of early diagnosis in all cases.

The most important early symptom of laryngeal carcinoma is some alteration of the voice. At first there may be merely weakness or huskiness; later hoarseness and aphonia develop. As the growth increases in size, interference with breathing will become evident, and will be followed by dyspnea.

Most cases occur in males and after the age of 40. However, Clerf has reported a case as early as 21 years of age, while MacKenty (5) records one at 20 and another at 29 years of age. New (6) records a case at 16 and one at 20. Any adult patient who has chronic hoarseness without symptoms of tuberculosis should be suspected of having a new-growth in the larynx, and a careful laryngeal examination should be made in every such case.

The growth usually begins as a localized bulging on one of the vocal cords. The surface of the cord is first attacked, but if the invasion continues, the deeper tissues are involved with later extension to surrounding structures. Carcinoma of the larynx has a tendency to involve the anterior two-thirds of the cord, which is a helpful point in diagnosis. The local appearance of the lesion has been clearly described by MacKenty as follows:

> Incipient cancer in an otherwise normal larynx has the following distinguishing features. It has none of the appearances of inflammation. The area around the minute excrescence or bulging irregularity of surface may be normal in color or paler than normal and raised above the surrounding surface. It is rarely pedunculated and is usually flatly sessile and irregular in outline, with little or no demarcation from the normal surrounding tissue into which it fades. It may present early a broken, warty, abraded appearance. Its base or point of emergence from the normal tissue may exhibit vascular activity, as shown by dilated surface venules. Rapid growths often take on a pale yellow or dirty white appearance and suggest, in the diminutive, the later well known cauliflower appearance of malignancy.

In all cases of new-growths in the larynx, the final decision must be made by taking a piece of the growth for microscopical study. This section is easily obtained through a direct laryngoscope, it can be quickly made, and the procedure is not dangerous to the patient.

There has been considerable controversy about the question of biopsy in these cases, but if the section is carefully made and the remaining raw edges of the growth are cauterized by endothermy, there is little danger that metastasis will develop. Of course, one should always be prepared to remove the growth as soon as possible after a definite diagnosis has been made.

There are several chronic laryngeal lesions which call for differential diagnosis. As laryngeal tuberculosis is one of the most common chronic laryngeal diseases, a few differential points of the two diseases will be considered.

Tuberculous laryngitis presents a typical picture. It is a secondary manifestation and some general lesion is always associated with it. The tubercle has no characteristic tendency to involve a certain part of the larynx as is seen in cancer. The lesion may be single or multiple, most often being seen in the arytenoids, the interarytenoid space, the vocal processes, one or both cords, the epiglottis, or in the pharnyx. The early pathological changes produce edema, infiltration, and later breaking down, with ulceration and secondary infection. The ulceration at first is superficial with later extension into the deeper structures, causing irregular loss of tissue. The vocal cords often present the typical "moth eaten" appearance.

The co-existence of the two diseases in the same patient is extremely rare. In a study (3) of over 6,000 cases of laryngeal tuberculosis at the State Sanatorium, I have found only 1 case of carcinoma associated with tuberculosis.

Chronic laryngitis, in which there is some edema or infiltration of one of the vocal cords, in older persons may at times present a serious problem in differential diagnosis. But usually some focus of infection can be found in the tonsils, teeth, or sinuses, removal of which will clear up the laryngitis.

Syphilis of the larynx has been uncommon in my practice. Hoarseness occurring in the secondary manifestations of the disease is usually associated with other general symptoms so that a diagnosis can be easily made.

Furthermore, as this is a blood disease, there is usually uniform injection and infiltration of both cords. A Wassermann test is also of great help. Cases causing most concern are those in which the patient has a true cancerous growth with syphilis. Many of these cases have been carried into the late stages of metastatic involvement by attempting to treat the lesion as syphilis. In all such cases the question of diagnosis should be decided by biopsy.

## TREATMENT

The treatment of carcinoma of the larynx depends upon the individual patient, as no common method of procedure can be applied to every case. It is now generally recognized that there is considerable variation in the degrees of malignancy. The various lesions have been graded by Broder's method, so that a careful study of the type of cancer must be made before operation is decided upon.

*Operations.* Endolaryngeal operations have not been very successful in the treatment of cancer of the larynx and are now seldom attempted with the expectation of obtaining a cure. Likewise, treatment of such growths with radium has been disappointing, and it is now used only as a palliative measure. No doubt the inaccessibility of the larynx for direct application has been the cause of failure in some cases. If large doses of radium could be applied directly to the growth as in skin cancer, the results would be better.

*Laryngofissure.* This operation is ideal for early laryngeal cancer—cases in which the growth is limited to the anterior surface or free edges of a mobile cord. St. Clair Thomson claims that 80 per cent of suitable cases can be cured by laryngofissure. Chevalier Jackson has had equal success with this operation in America, and has perfected a technique which is generally followed by most surgeons in this country. This operation is safe, gives the patient a useful voice, free airway, and little disability, and should be used whenever possible. It is unfortunate that only about 20 per cent of cases of laryngeal cancer are recognized early enough for this operation. The rest require a more radical procedure, such as laryngectomy.

*Laryngectomy.* Early operations for total laryngectomy resulted in such serious complications and were attended with such high mortality that little prognosis was made with this surgical procedure until within recent years. Unreserved credit must be given to MacKenty for his persistent investigations and classical contributions to the study of cancer of the larynx. The perfection of his technique for total laryngectomy, with results which have been unequalled by few, has given us an operation which can now be followed with assurance and can be recommended to be the most certain method of cure in selected cases in which the growth cannot be removed by more conservative methods. Improvement in technique, with the more rapid recovery and cure of the patient as its purpose, should be the aim of every operator. Therefore, the object of this paper is to emphasize a few points which have proved successful in my hands.

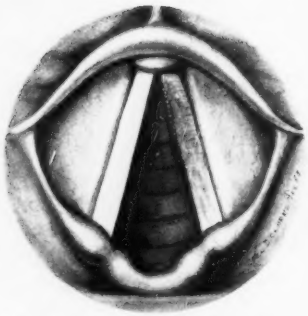

Fig. 1. Early carcinoma of the larynx.

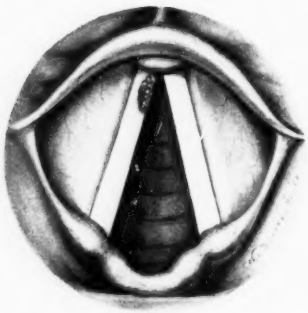

Fig. 2. Type lesion of laryngeal cancer suitable for laryngofissure.

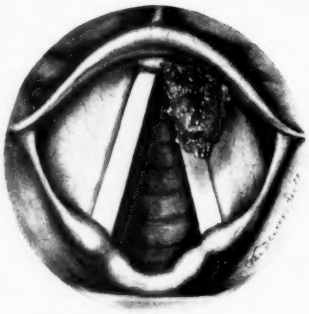

Fig. 3. Case of cancer of the larynx in which laryngectomy is indicated.

The one stage operation is preferred. Its obvious advantages are so well understood that unnecessary discussion is not required. Of course a few patients will present such an obstructive growth, with marked symptoms of dyspnea or with a history of a previous tracheotomy, that a two stage operation will be indicated. But these complications are in the minority.

It is gratifying to state that this operation can now be performed by those skilled in its technique with as much safety and with as good a prognosis as to cure as any other major operation.

*Pre-operative attention.* As this disease occurs most frequently in elderly people, consideration must be given to the patient's ability to stand such an operation. Investigation must be made to discover complicating diseases which occur at this time of life, and every patient should be carefully examined and treated, if necessary, by an internist before the operation is contemplated. Diabetes and nephritis are common. Hypertension should be suspected. Infected teeth or other focal infections in the nose and throat should be removed. In fact, all factors which affect the patient's general resistance should be corrected before the operation is performed.

*Anesthesia.* Before the perfection of rectal anesthesia, it was a common practice to perform most laryngectomy operations under local anesthesia. With gaseous anesthetics, usually employed, definite difficulties are added to the operation. The anesthetist is necessarily so close to the field of action that he is in the way. Even extended rubber tubes embarrass the surgeon in his work. Most important of all, the concentrated fumes of ether on the mucosa of the lower trachea and bronchi in dehabilitated patients is always a matter of concern to most operators. These complications of course can be avoided by block and infiltration anesthesia, but local anesthesia also has its disadvantages. The patient is conscious, and this is a serious handicap. It is extremely depressing to most people to learn that they have cancer, but to know that they must lose their organ of voice is a real tragedy. So to lie on an operating table for several hours meditating on their misfortune, while their vocal cords are being removed, produces a mental shock and vasomotor disturbance which must affect the immediate recovery from the operation and certainly prolongs the convalescence. By the use of rectal anesthesia many of these difficulties are overcome. We prefer avertin and invariably use it as a basal anesthetic. In most cases the entire operation can be completed while the patient is under the influence of this drug alone. However, if necessary, a small quantity of ether in olive oil can be satisfactorily given per rectum as the particular case demands. With avertin the patient goes to sleep easily, quietly, and quickly. This is a very important factor and one which frequently prevents the necessity of a preliminary tracheotomy, which is required if there is excitement, struggling, or a spasm of the constricted glottis, a condition associated with the excitement stage of gaseous anesthetics. With avertin, the blood pressure is lowered, the breathing is quieter, and the patient sleeps for several hours, a very important advantage.

After using this method for several years, we are convinced that this is the ideal anesthetic for this operation and so far we have had no complications and have seen no bad effects from its use. There is one precaution, however, to be observed: The solution should never be given in the patient's room, but should always be administered on the operating table because if dyspnea, due to the growth, should develop, an

Fig. 4. A crescentic incision is used in laryngectomy.

Fig. 5. Larynx exposed. Cut transversely below. Posterior tracheal flap preserved.

immediate tracheotomy can be performed more satisfactorily.

*Technique.* The skin (anterior part of neck and upper part of chest) is shaved and carefully scrubbed with soap and water. This can be done before the patient comes to the operating room if preferred. While the patient is going under the influence of avertin, the desired area is now cleansed with alcohol, ether, and iodine, or Scott's solution, the application depending upon the choice of the operator. The neck is now extended as much as possible and the necessary draping arranged. Suction, with suitable small tubes, should be in good working order. Naturally, a complete tracheotomy set should be at hand with the other required instruments.

*Incision.* Particular attention should be paid to the preliminary skin incision. I prefer a crescentic incision on the right side of the neck. Beginning above, near the midline at the highest point of the right thyroid cartilage, it is extended downward and outward until the central part of the incision is on a line with the inner margin of the sternocleidomastoid muscle. From here the incision is carried downward and inward to the midline on a level with the first tracheal ring (Fig. 4).

Such an incision, to my mind, has several advantages over the customary T-shaped incision. The most important feature of the crescentic incision is that there is less weakness in the midline of the throat, where strength and support are so essential after the larynx has been removed. Infection is less likely and healing is more rapid. On account of lessened traumatism and undisturbed blood supply over the esophageal region, fistulas do not develop so frequently. The larynx is easily exposed and satisfactorily delivered. There is less scarring with a final result of little deformity in the conspicious midline of the throat. If desired, a cutting endotherm may be used for cutting and dissecting throughout the operation. Such an instrument causes less bleeding and may lessen the chances of metastasis by searing over raw surfaces. However, this is a matter of choice.

The fascia and attached muscles are now cut and pulled aside and the larynx carefully skeletonized. All bleeding points should be tied off and the larynx packed around with sterile gauze. The greater cornua of the thyroid cartilage are now pulled up and severed near their ends. The larynx is then allowed to return to its normal bed. The thyroid ligament is now cut, separated from the trachea, and pulled aside. The upper end of the trachea is freely exposed and a clean transverse incision is made through the trachea down to, but not across, its posterior surface. At the posterior wall an elliptical or tongue-shaped incision should be carried upward, sufficient in size to make a satisfactory mucosal flap (Fig. 5). This flap is important as it strengthens the fixation of the tracheal stump and prevents irritation of the thin esophageal wall by the tracheotomy tube. The patient's head is now lowered to prevent blood and mucus from getting into the trachea and bronchi. An aspirator should be constantly used by an assistant to prevent such complications, for it is difficult for a patient to cough out secretions when once the trachea is opened. If desired, a large tracheotomy tube can now be inserted into the trachea and packed around with vaseline gauze. However, this can be deferred until later if the assistant is on his job.

After the trachea has been detached as de-

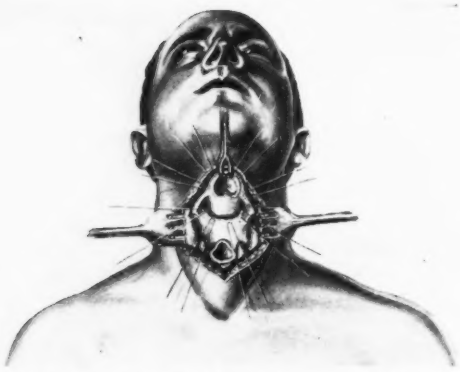

Fig. 6. Larynx dissected from below upward. Mattress sutures inserted above.

Fig. 7. Larynx severed above. Esophageal lumen packed with gauze.

scribed, the lower anterior end of the larynx is grasped with a volsellum forceps and lifted up. Now very carefully the posterior wall of the trachea is separated from the anterior wall of the esophagus; caution is necessary here because the wall of the esophagus is very thin and a perforation will cause a fistula. This dissection is carried upward until the lower end of the trachea can be lifted out of its bed and a saline pack placed posteriorly. The trachea is now allowed to drop back into its natural position.

My next step is a slight deviation from that usually employed. Several mattress sutures of chromic catgut are inserted through the outer wall of the esophagus at the upper end in a line where the trachea is to be cut from the esophagus (Fig. 6). The object is to do all possible work and manipulation before the esophagus is opened so as to prevent as much infection and contamination of the wound as possible. The sutures are also helpful in lifting up the larynx and later in closing over the esophageal opening. The larynx is now entirely separated from the esophagus and the raw edges of the esophageal mucosa cauterized to prevent possible infection. From this point on there is danger of contamination from the opened esophagus, but to prevent as much of this as possible, a sterile saline pack is inserted into the end of the esophagus from without (Fig. 7).

An assistant now passes a small rubber feeding tube through the nostril and pharynx and down to the central part of the esophagus for future feeding. The tube is held above by adhesive tape attached to the face. The assistant now pulls the gauze pack up and out through the mouth and not through the wound.

The cut edges of the esophagus are inverted and the mattress sutures brought across and tied. The closed opening has the appearance of a T. Several smaller interrupted sutures may be necessary to close any exposed points as it is very important to have a tight wound to prevent leakage and fistula formation (Fig. 8). All gauze packs should now be removed and a final inspection made to see that all bleeding is controlled and that the entire wound is thoroughly dry. The cut end of the trachea is brought up and fixed to the skin by silk sutures. The surrounding skin edges are inverted so as to form a smooth surface, which on healing will give a good cosmetic result; they are extended sufficiently so that they will remain open after contraction and thus make it unnecessary to wear a tracheotomy tube permanently (Fig. 9).

Closure of the wound adjoining the tracheal opening above is most important. An effort should be made to establish a firm bridge of tissue which will heal quickly, so as to prevent drainage from above to enter the trachea. Muscles and fascia should be carefully closed over in this area and securely sutured to insure close approximation of the tissues and to prevent pocket formation. A long braided silk suture on a large cutting hand needle, carried through the skin into the deeper structures across this bridge so as to come out on opposite skin surface, gives retention and support to this important area.

The next step consists in closing over the esophagus. The related neck muscles and fascia are now carefully approximated and sutured in order to form a cover and a strong support to the anterior wall of the esophagus. Close apposition of this tissue over the incised area greatly aids rapid healing and lessens the chances of fistula formation.

Fig. 8. Raw edges cauterized, opening closed carefully with chromic catgut.

Fig. 9. Muscles and fascia brought together, drains inserted.

Provision should be made for the insertion of three or four small rubber drainage tubes. Small tubes are as satisfactory as the larger ones and give sufficient drainage unless infection should develop. These tubes should be left long enough to extend out through the dressings.

The skin wound is now closed by interrupted silk sutures. Along the line of incision a final application of iodine or Scott's solution may prevent skin infection (Fig. 10).

Vaseline rubber gauze is used to cover the wound and a perforated piece is placed under the tracheotomy tube, which is finally adjusted and secured by tapes around the neck. Gauze handkerchiefs are placed over the wound and are held in place with a roller bandage.

*After-treatment in laryngectomy.* The after-treatment of a laryngectomy patient is almost as important as the operation.

Exacting vigilance is required with every case. The resident and nurse must be made to realize how much depends upon them for the patient's recovery. While returning from the operating room the patient's head should be lowered. A suction machine should be placed at the bedside for immediate action and should be used at all times when secretions accumulate in the trachea and bronchi. This exudate can be aspirated with a small curved cannula; this procedure will relieve the mucosa of infected material which is often the cause of one of the chief complications, bronchopneumonia. Attention to this factor must be observed throughout the patient's convalescence. Dressings should be changed twice daily until the wound has healed. Iodine solution applied to the skin incision will prevent infection and stimulate healing.

In these cases proper feeding is essential. Concentrated liquids should be administered at frequent intervals through the feeding tube, to build up the required resistance. At the end of a week or 10 days, the feeding tube can be removed and some sterile water can be taken by mouth as a test. If an esophageal fistula is present, the tube should be reinserted until healing is complete.

*Complications.* Hemorrhage, usually considered the chief cause of anxiety, should not occur if the vessels have been carefully tied off at the time of the operation. It has not developed in any of my cases.

Bronchopneumonia can also be prevented by regular aspirations of secretion with a suction outfit. The patient should also be forced to change his position frequently and should be allowed to sit up in bed at intervals during the day.

Fig. 10. Tracheal opening fixed, skin wound closed with tape and fine silk sutures.

Fistula formation, a common complication with the T incision, is less likely to occur if there is strong support over the esophageal incision, as employed with the technique described. If a fistula does develop, it is of no serious consequence and usually heals in a reasonable time, but if persistent, it can be closed under local anesthesia.

*Results.* In a series of 35 cases, no serious operative complications or fatalities have occurred. The convalescence has been satisfactorily rapid and pleasing. These patients are not depressed and most are made happy and given a new lease on life with the aid of the artificial larynx.

Finally, this operation, performed under methods of improved technique, stands equal, in safety to the life of the patient, to that of other major operations. New and Waugh (7) have reported only 1 death in 135 laryngeal operations; in 75 of these cases thyrotomy was done and in 60 laryngectomy. In my series of 35 laryngectomies, I have had no operative mortality, no serious complications, and the final results have been satisfactory.

SUMMARY

1. As cancer has become the second greatest cause of death, the relative increase in laryngeal carcinoma presents an important laryngeal problem.

2. No opportunity should be lost to impress upon the profession the urgent necessity for early recognition of this disease because early diagnosis and prompt surgical removal mean cure. If neglected, the prognosis is less hopeful.

3. Surgery still offers the most satisfactory method of treating cancer.

4. The increasing use in these cases of conservative procedures, such as x-ray and radium, calls for a note of warning. An operation is often made more difficult and delay may result in loss of life.

5. Laryngofissure is the ideal operation for early laryngeal cancer and will cure about 80 per cent of the cases.

6. Laryngectomy is now a safe surgical procedure. By improved technique the mortality rate has been reduced from about 50 per cent in the earlier operations to about 1 per cent at the present time. The operation should be recommended with assurance that the results will compare favorably with any other surgical procedure. With the artificial larynx, patients are made happy and are often given many years of useful life.

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## Discussion

Dr. Chevalier Jackson, Philadelphia: All of the author's well presented statements are corroborated by my experience. I have seen the reduction in the operative mortality of laryngectomy to which he refers. Twenty-seven years ago I reported a series of 14 laryngectomies with the operative mortality of 14 per cent. Our present operative mortality is almost but not quite as low as that of the essayist, about 2 per cent. Obviously there need be no hesitation on the part of the surgeon in advising, or on the part of the patient in consenting to, laryngectomy because of operative risks, if the patient is a fair average as a subject for major surgery. I am delighted with Dr. Looper's opinion on the advisability of laryngofissure in suitable cases. The condition of the patient after laryngectomy is so incomparably inferior to that of a patient after laryngofissure that we should consider the subject of prophylaxis of laryngectomy. One cannot help but deplore the unquestionable fact that the presence of cancer of the larynx is still overlooked when it is in the stage curable by laryngofissure. Of the last 254 patients with cancer of the larynx that have come to the service of Dr. Chevalier L. Jackson and myself at Temple University Hospital, only 23 per cent were suitable for the relatively minor and nonmutilating operation by the laryngofissure route. By this route 82 per cent of suitable cases are in the curable class. Yet there can be no worse mistake than to attempt removal of extensive or extrinsic laryngeal cancer by the laryngofissure route. Doing so has led to lack of appreciation of this great boon to humanity, or at least to the part of humanity represented by the patient with early intrinsic cancer and his family.

One thing is incomprehensible to me, and that is the existence of international differences in the choice of operation as between laryngectomy and extirpa-

tion by the laryngofissure route; it is especially curious that such differences should persist so long after Sir Felix Semon first called attention to them. Sir St. Clair Thomson, Herbert Tilley, and Hunter Tod 22 years ago referred to Dr. Ellen J. Patterson and me at Pittsburgh a man with very early cancer of the left vocal cord with the advice that we do a laryngofissure. Not one of the consultants in the case even mentioned laryngectomy. A great surgeon visiting our clinic said, "You will be sorry you did not do a laryngectomy on that man." Dr. Ellen J. Patterson and I were never sorry. The man is now alive and well with a good voice, and breathes through his mouth 22 years after laryngofissure. This is one of many similar cases. Yet even today here in the United States laryngectomy is being advised and done in just such cases. It is incomprehensible to me why our Canadian friends, not 400 miles away, should be getting 80 per cent of cures by laryngofissure in a class of cases of cancer of the larynx in which laryngectomy is being advocated and done here in the United States. It is easy to understand why a general surgeon who has never done a submucous resection of the septum should have no fondness for doing intralaryngeal dissection by laryngofissure; but it is incomprehensible why laryngologists should use the laryngofissure route relatively seldom.

The fact that gross statistics show that 90 per cent of the patients with cancer of the larynx die of cancer of the larynx, which is a disease curable in 82 per cent of the cases, renders it worth while to repeat here what I have said before: There are 3 means for reducing the deplorable number of avoidable deaths from this "dire disease," as Mr. Butlin called it. It seems to me that there is urgent need of three things, namely: (1) The family physician should be educated to the fact that hoarseness in an adult, even if intermittent or apparently recent, means cancer of the larynx until it is proved otherwise by every diagnostic means we possess. Parenthetically it should be stated that this good rule will not work backward; absence of hoarseness does not exclude cancer. (2) We as laryngologists should never exclude cancer without seeing the anterior commissure and the interior of the ventricle; death often lurks under an overhanging epiglottis; less often under an overhanging ventricular band. (3) The layman must be taught to report to his family physician promptly in case of hoarseness. I repeat what I have often said, the laity should be taught that curing cancer is like putting out a house afire; easy early, impossible late. I repeat it, because no one seems ever to have paid any attention to this homely way of stating a surgical platitude to the laity.

# TRAUMATIC DEFORMITIES OF THE NOSE AND OTHER BONES OF THE FACE

GORDON B. NEW, M.D., F.A.C.S., Rochester, Minnesota

BECAUSE of the hazards of the present methods of transportation, many patients are seen who have incurred extensive traumatic deformities of the nose and other bones of the face which require correction. Only too often these conditions are overlooked at the time of the accident, because more serious injuries demand immediate attention.

Although the deformities may involve one or more regions, for the purpose of consideration they may be divided into five groups: deformities (1) of the nose itself, (2) of the nose and forehead, (3) of the malar region and orbit, (4) of the upper jaw, and (5) of the lower jaw. In addition to these, injuries to the soft tissues require separate consideration.

## DEFORMITIES OF THE NOSE

The surgeon should familiarize himself with the position of the nasal bones, the nasal process of the superior maxilla, the upper lateral cartilages and the cartilages of the ala and the septum, which are commonly displaced in trauma to this region.

Injuries to the nose may produce displacement in various directions. Traumatic force may be exerted in an anteroposterior direction, so that the nasal bones and the cartilages below them may be flattened and spread out on the face.

A second type of deformity may be the result of an injury directed laterally, so that the nasal bones are displaced to one side.

A third type may be an injury producing an S-shaped deformity; that is, the nasal bones are displaced to one side, the upper lateral cartilages to the opposite side and then the lower portion of the nose is displaced to the same side as the nasal bones.

These conditions may be treated either early or late; some injuries are seen immediately or shortly after the accident and it is possible immediately to replace the displaced parts, and other injuries may not be seen until several weeks or months later when the parts have become fixed in their new position.

From the Section of Laryngology, Oral and Plastic Surgery, The Mayo Clinic.

Presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

In the treatment of recent nasal fractures, lacerations about the nose, if present, should receive the first care. Often there are particles of foreign material in the wound which should be removed; the wound should be carefully cleansed with an antiseptic solution and any bleeding should be carefully controlled. The skin should be sutured with subcuticular catgut and fine silk. The fractured parts should be placed in position and, as a rule, manipulation, with the patient under anesthesia with nitrous oxide, is all that is necessary for this. I prefer to use vaseline packs in the nose rather than any type of intranasal splint. Occasionally a suture, which is run directly through the nose on each side and held in place by a button of lead, may be employed to hold the bridge of the nose in position. An aluminum splint, which is shaped to fit the outside of the nose, and is lined with a layer of gauze, is used to hold the nasal bones in position; an antiseptic varnish (mastisol) and gauze, or tape, are employed to hold the splint in position. An ice bag is held to the injured region outside the dressing.

If, at the time of the accident, the injury has been such that the patient is unconscious, and the nasal bones and frontal processes have been driven posteriorly, it is much better to wait and not to attempt to correct the deformity, for any further trauma may aid in the production of meningitis.

The deformities that are seen later require careful study to determine just what procedure should best be used to correct them. Frequently, refracturing of the nasal bones and adjustment of the nasal cartilages will correct the deformity without the use of any additional cartilage. In general, it is best to employ such procedure. However, cartilage may have to be used when the refracturing operation is being performed (Fig. 1).

When the nasal bones are to be refractured, the incision is made inside the nose on each side at the lower margin of the bones and, after the skin over the dorsum of the nose is freed, a small chisel is used at the base of the nose; then by means of a ring forceps the bones are refractured and placed in correct alinement. In most cases

this simply means elevating the bridge of the nose as one would elevate a low ridge pole of a tent. Usually, through a separate incision below the tip of the nose, extending laterally into the ala, the cartilages of the nose are replaced in the correct position and sutured in place with catgut. If the displacement has been lateral, refracturing of the concave side first, and then of the convex side, brings the bridge of the nose into correct alinement. In cases in which the injury to the nose has occurred some time before and the nasal bones are displaced laterally, it is usually necessary to take a wedge of the bone, with the apex upward, out of the concave or wider side of the nose in order to allow the nose to be brought into the median line. It is always essential to mobilize the nasal bones from their frontal attachment. A suitable splint is applied externally to fix the bones and cartilage in position.

One often sees cases in which cartilage has been inserted to correct such a deformity and in which the material itself that is present could be utilized to accomplish the same result. In many cases, however, in which the injury has occurred when the patient was a child, there is such marked deformity present that the use of cartilage is the only method that will correct such a deformity.

In all deformities of any extent, a cast is made and the deformity is corrected in wax on the cast. From this, patterns are made to show the extent on the surface and also the depth of the deformity. These patterns can be taken to the operating room and used when the nose is being reconstructed.

In many cases the area to which the cartilage is to be grafted is so irregular that it is necessary first to chisel off the irregularities and then smooth down the bed for the cartilage before it is inserted.

The deformities may be at the upper or at the lower part of the nose. In those which are at the upper part, I sometimes use bone as well as cartilage from the rib. In those which are at the lower portion of the nose, I prefer to use cartilage alone. In such cases I always remove the full thickness of the cartilage of the rib, and then model it on a separate table to the necessary size and shape, using the patterns that have been made from the casts. Cartilage is usually removed from the seventh and eighth ribs and is inserted into the nose through a small incision below the tip. In some cases, when the destruction has been such that the cartilage is entirely absent from the septum, it is necessary to use a post, placed downward against the superior maxilla, to elevate the cartilage used to form the bridge. The anesthetic of choice is nitrous oxide given intratracheally, and the tube is inserted through the mouth.

Fig. 1. Traumatic deformity of the nose: a, left, before operation; b, after operation. The deformity has been corrected by refracturing the nasal bones and by adjustment of the cartilages.

Injuries to the noses of children are much more difficult to correct because of the presence of cartilage rather than bone, so that in some of these cases, even if correction immediately follows the injury, there will be a tendency later to flattening of the nasal bones and cartilages, which will have to be corrected when the child becomes older.

Some patients have "humps" about the nose which they attribute to accident. Many of these appear to be of congenital origin. The correction of these should depend not only on the extent of the deformity, but on each patient's reaction to operation and on his expectations. Few patients are more appreciative of the correction made than are those who have had merely a slight nasal deformity which was producing a great deal of unhappiness. The technique of correcting the nasal humps and making changes in the size of the ala has recently been well described by Safian.

Loss of part of the nose, including the skin and cartilage, particularly the lower third, can be corrected either by taking skin from the forehead or from the region behind the ear, as suggested by Straith, or by skin from the supraclavicular region. The essential factor is to obtain skin that is of the same texture and color as that of the nose and to fold it on itself to form a good tip and columella. For women, I prefer skin from the forehead in most cases when the greater part of

Fig. 2. Traumatic deformity of the nose and forehead: a, left, before operation; b, after operation. The nasal bones have been refractured and a cartilage implant made.

Fig. 3. a, left, Traumatic deformity of the malar region, lower margin of the orbit, nose, and upper lip; b, postoperative photograph, showing deformity corrected by cartilage implants and plastic operation on the nose and upper lip.

the nose has to be reconstructed, as it makes for a better cosmetic result than has been that obtained in any cases that have come to my attention, in which the skin for the reconstruction has come from other parts of the body. The tip may be reproduced by taking skin from behind the ear by means of a tubed flap.

### DEFORMITIES OF THE NOSE AND FOREHEAD

Frequently accidents which produce injuries about the face cause marked deformity in the frontal region, base of the nose, and upper jaw. The forehead, glabella, and nose are driven backward into the ethmoid region, and the patients are usually in a very serious condition. At the time of injury I am of the opinion that no attempt should be made to correct the deformity because of the possibility of meningitis. Later, preferably 6 months from the time of the accident, the injury should be corrected. In this group of cases the use of casts is essential in order to determine the area and depth of the deformity, and then patterns are employed to determine the amount of cartilage from the rib required to correct the deformity. In these cases the cartilage can be inserted through the scar. In some cases it is necessary to remove the full thickness of three ribs in order to obtain enough cartilage to build up the region destroyed. In one case, noted at the clinic, two ribs were used to build up the forehead and the third to build up the bridge of the nose. In such cases the missing tissue is built up with cartilage, on a table, and each piece is fitted to the other until the lost portion has been reproduced. In the forehead, free fat has been used to restore some of the tissue, loss of which is responsible for these deformities, and the results in some cases have been good. However, in general, I prefer cartilage for this purpose (Fig. 2).

### DEFORMITIES OF THE MALAR REGION AND ORBIT

Fractures of the malar bone are frequently associated with fractures of the nasal bones and the superior maxilla. The body of the malar bone, however, is usually not fractured but rather the process by which it is connected with the adjoining bones. These consist of the frontosphenoidal process at the outer wall of the orbit, the orbital-maxillary process (the attachment to the superior maxilla and the lower margin of the orbit), and the zygomatic process (the attachment to the zygomatic process of the temporal bone). The face is flattened when such a deformity is present, and frequently there is protrusion of the contents of the orbit, limitation of motion of the eye and sometimes fixation of the lower jaw, caused by pressure on the coronoid process. Palpation usually reveals irregularity at the outer and lower margin of the orbit; hemorrhage into the nose is of common occurrence and is caused by fracture into the antrum. Frequently, in this type of deformity, the fracture is comminuted. Roentgenograms reveal absence of the lower lateral angle of the orbit because of the displacement of the bones inward.

Correction of the displaced fracture of the bones, I believe, is best done by means of a hook. A small nick is made in the skin; then the hook is passed below the fragment, the fragment is elevated until it impinges on the fixed portion, and the two are approximated. The hook is made of

Fig. 4. a, left, Ununited fracture, with loss of the bone of the left lower jaw, showing displacement of the posterior fragment without teeth inward and upward; b, a plaster-of-paris skull cap with coat hanger wire encased in it pulls the distal fragment backward and outward by means of a wire inserted at the angle of the jaw; c, showing separation between the fragments accomplished by means of the external splint; also the bone graft in place; and d, postoperative roentgenogram, showing the bone graft with good function.

heavy steel wire with the ring bent at the distal end of the handle on the opposite side to the hook but on the same plane as the bend in the hook itself, so that the surgeon always knows the plane of the hook when it is buried in the cheek. The advantage of the hook over all other devices employed, such as the various types of elevating sets, is that, if there is a great deal of comminution and the bone does not become fixed and remains in position after it has been elevated, gauze can be used around the hook and between the skin and the ring of the handle, in order to hold the fragment in elevation until fixation has taken place. In late fractures, after the bones have become fixed and there is a deformity of the margin of the malar bone, cartilage is the best material to use to repair such deformities. It is essential in these cases to use a cast and to build up the deformity in wax in order to determine the amount of deformity present. If the lower mar-

Fig. 5. a, left, Traumatic loss of the lower jaw, extending from the cuspid region to the glenoid cavity, replaced by means of a bone graft 9 years ago; b, recent roentgenogram, showing bone graft in place and normal function

gin of the orbit has been lost, a piece of curved rib will replace this lost bone very satisfactorily. If more extensive trauma has taken place, for example, when the malar bone has been crushed in addition to loss of the margin of the orbit, several full thicknesses of rib can be utilized to correct the deformity. These should be fitted together to conform with the size and thickness of the patterns that have been made. Cosmetic results in this group of cases have been very satisfactory (Fig. 3).

### FRACTURES OF THE UPPER JAW

Fractures of the upper jaw are commonly associated with those of the nose and malar bones. There may be a displacement, backward or lateral, of the upper jaw and teeth. The fracture may be comminuted, with several loose fragments. Fragments that cannot be replaced satisfactorily and appear as if they would not live, because of impaired supply of blood, should be removed along with the loose teeth. Sometimes a four tail bandage is all that is necessary to hold the lower jaw against the upper jaw, the occlusion of the teeth holding the upper jaw in correct alinement. If patients are seen within a week or 10 days, it is possible at times to utilize rubber bands attached to crowns about the teeth in order to draw the displaced fragment downward and forward.

### FRACTURES OF THE LOWER JAW

This is a rather common fracture associated with injuries about the face and, in general, in cases in which the teeth are present, wiring the teeth together by means of silver wire gives excellent results and good function. When few teeth are present, it is necessary to use a heavy wire fixed in position to the remaining teeth in the upper jaw and another fixed to the remaining teeth in the lower jaw, and then to attach these two heavy wires together, thus producing fixation. At times, interdental splints made of vulcanite or splints attached to casts on the head are necessary in order to pull the fragments into correct alinement. One of the causes of ununited fracture of the lower jaw is a fracture through, or close to, a tooth. At the time of injury, it is best to remove any teeth that are in the line of the fracture. This frequently will help to avoid a secondary phlegmon of the neck and will prevent an ununited fracture.

Patients who are seen late and who have discharging sinuses in the neck and in the mouth frequently need only removal of teeth that are approximating the line of fracture, and curettement of the sinus to produce union. Ununited fractures of the lower jaw, with loss of tissue, if function is good, do not require any treatment. However, if tissue has been lost and displacement of the jaw interferes with mastication, bone grafts should be employed to correct the deformity (Fig. 4a). It is essential in these cases, if teeth are present near where the bone graft is to be used, to remove these teeth and wait 3 months in order to guard against any infection from the sockets.

Various types of grafts have been used; among these may be mentioned the sliding graft, in which a portion of the jaw is slid across to fill in a narrow space where tissue has been lost, and the osteoperiosteal graft, which is also employed if there is slight loss of tissue. If more than 2 to 2.5 centimeters of tissue is lost, it is best to employ a bone graft from the ilium to replace it. Fixation of the fragments is essential to obtain good union. If teeth are present in both fragments and also in the upper jaw, the wiring together of these teeth will fix the fragments in position. The posterior fragment, particularly if no teeth are

present, usually pulls upward and inward, and the method suggested by Darcissac has been found to be very efficient for fixing this fragment. A cast is made over the head like a skull cap (Fig. 4b), and in the cast is fixed a heavy wire, the thickness of a coat hanger wire, which extends downward to the mastoid region. A hole is drilled in the angle of the lower jaw, a silver wire is passed through it and this is fixed to the wire attached to the cast on the head. In this way the posterior fragment is pulled backward and outward and fixed in position. The anterior fragment often has teeth that can be wired to the teeth of the upper jaw. The crest of the ilium is a satisfactory place to obtain bone for grafting on the lower jaw. The bone above the antero-superior spine of the ilium is utilized to obtain a large piece, which can be fixed in position with chromic catgut after holes are drilled through the graft and ends of the bone.

The wound is closed without drainage and a pressure dressing is applied. Fixation is maintained for 2 months and then removed in order to allow motion (Fig. 4c). A large percentage of grafts utilized in this manner will give good function (Fig. 4d). Recently I was able to obtain roentgenograms of a bone graft which I had made 9 years ago and which had replaced the lower jaw from about the bicuspid region to the glenoid cavity. The roentgenograms revealed that the bone was in perfect position and that the patient had good function (Fig. 5).

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## Discussion

Dr. Warren B. Davis, Philadelphia: Dr. New has given us a concise, yet comprehensive consideration of the various injuries of the nose and face, with special attention to the types seen all too frequently, as a result of our modern speed mad transportation, or disregard of traffic regulations.

The primary treatment of the various injuries has been splendidly outlined, and when the importance of the early adjustment and fixation of fractures involving the bony and cartilaginous framework of the face is properly appreciated and carefully done, by qualified facial surgeons, our functional results will be greatly improved, and the necessity for secondary operations greatly minimized. Accurate anatomical knowledge of the relations of the deep, as well as superficial structures of the face is essential in securing accurate bony approximation and proper fixation.

Care in the preservation of the damaged tissues at the time of the early repair is essential in obtaining our best results. Gentle technique in handling the traumatized tissues, the frequent application of warm compresses over the injured areas, care in cleansing the nasal passages, and the minimizing of obstruction to ventilation and drainage from the sinus regions often allow the preservation of tissue, which at the time of injury seemed almost hopelessly damaged.

I am thoroughly in accord with the methods described by Dr. New for the correction of the traumatic deformities which we see long after the primary injury. In the extensive nasal depressions, which cannot be corrected by elevating the local cartilage and bone, rib cartilage transplants are certainly the most satisfactory. In smaller depressions in which the nasal respiratory area can be improved by submucous resection of the septum, not infrequently a satisfactory piece of septal cartilage can be secured and transplanted to correct or greatly minimize the deformity.

Another measure from which we have obtained satisfactory results in several instances is the use of the dermal graft in correcting depressions in the frontonasal area, or in correcting deformities resulting from depressed fractures of the anterior walls of the maxillæ. These dermal grafts may be taken either from the thigh or from the abdominal wall. The epithelium is carefully removed and the remaining skin and some of the subcutaneous fat is placed under the skin overlying the depressed area to be corrected. Some cases in which the depressions were corrected in this manner have been under observation for a period of 5 years, and no unsatisfactory results have arisen.

I know of no more interesting problems in plastic surgery than those presented in the correction of acquired facial deformities, and Dr. New has shown us, both by description and by his photographic records, how gratifying the results may be when the operations are done by a master of the art.

# SURGICAL RESULTS IN 223 CASES OF HETEROTROPIA

## Especial Reference to Orthoptic Training

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RESULTS effected by the combined orthoptic and surgical treatment of strabismus seem to justify the conclusion that methods of orthoptic training and the knowledge concerning the application of these methods have improved. When orthoptic training no longer decreases the deviation, operation usually should not be postponed. Following operation, orthoptic training should be begun as soon as possible.

Important rules to be followed in the surgical treatment of strabismus are: (a) correct refractive errors early; (b) overcome amblyopia early; (c) prevent suppression or the development of fixed abnormal retinal correspondence by early and continuous optic and orthoptic treatment; (d) begin training binocular vision as early as possible; (e) study aniseikonia, especially in relation to fusion; (f) operate early if orthoptic training is not producing the desired results.

I prefer to operate between the ages of 3 and 4 because, at that time, the deviation can usually be measured with the screen test and prisms; the degree of binocular vision can be determined fairly accurately; lenses and orthoptic training have probably accomplished their primary purpose; and finally, the patients are old enough to cooperate in postoperative orthoptic training.

### SELECTION OF SURGICAL TECHNIQUE AND THE MUSCLE TO BE OPERATED UPON

In high degrees of esotropia with normal relative or absolute near point of convergence and no limitation of adduction, I usually perform bilateral retroplacement of the medial recti followed, if correction is incomplete, after a period of orthoptic training, by resection of one or both of the lateral recti. In patients with high degrees of exotropia due to divergence excess, bilateral retroplacement of the lateral recti is usually performed first, followed by converging exercises. If the desired result is not obtained, resection of one or both of the medial recti is performed.

In paralysis of the superior rectus, when the error is low, I advise lengthening or intracapsular resection of the inferior oblique of the opposite eye. If the error is high, myotomy of the inferior oblique may be performed. If the error is greater than 10 prism diopters, myectomy of the inferior oblique is advisable and may have to be followed by resection of the superior rectus. If the inferior rectus is paralyzed, resection of the paralyzed muscle is to be preferred, although guarded retroplacement or lengthening of the superior oblique of the other eye may also be required. If the superior oblique is affected, tenotomy or lengthening of the inferior oblique of the same eye or retroplacement of the opposite inferior rectus is advisable, or the superior oblique may be advanced. In paralysis of the inferior oblique, retroplacement of the superior rectus of the opposite eye may be performed, possibly combining this procedure with advancement of the inferior oblique.

Since excellent results may be obtained by various means, the selection of the muscle to be operated upon and the type of operation to be performed should depend upon the experience and judgment of the surgeon, based upon pre-operative and operative findings.

### RESULTS OF SURGICAL AND ORTHOPTIC TREATMENT OF ESOTROPIA AND EXOTROPIA

Two hundred and twenty-three patients who were operated upon for strabismus were classified as follows: (1) patients who were operated upon and received no orthoptic training; (2) patients who received orthoptic training following operation; and (3) patients who received orthoptic training both before and after operation. The results were tabulated according to Worth's classification of binocular vision as follows: (a) first grade (superimposition), (b) second grade (fusion), and (c) third grade (stereopsis). The cases were classified also in regard to whether heterophoria was developed or whether heterotropia persisted.

Group 1. In the first group, 49 patients with heterotropia were operated upon and received no orthoptic training. There was no pre-operative record of the grade of binocular vision in 48 of these patients; in 1 patient the vision in one eye was suppressed. Postoperatively 3 patients had

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second grade binocular vision; there was no record of the binocular vision in 46. Following operation heterotropia persisted in 46 patients (94 per cent), while 3 (6 per cent) developed heterophoria.

Group 2. This group in which operation was followed by orthoptic training includes 85 patients. Prior to treatment, third grade binocular vision was present in only 3 patients (3 per cent); second grade binocular vision in 10 (12 per cent); and first grade binocular vision in 8 (9 per cent). Suppression, alternation, diplopia, and abnormal retinal correspondence, respectively, were present in 38 patients (45 per cent), while there was no record of the grade of binocular vision in 26 (31 per cent).

Following surgical and postoperative orthoptic treatment, third grade binocular vision was present in 29 patients (34 per cent); second grade binocular vision in 16 (19 per cent); and first grade binocular vision in 7 (8 per cent). Diplopia, suppression, abnormal retinal correspondence, and alternation, respectively, were present in 22 patients (26 per cent); there was no record of the grade of binocular vision in 11 (13 per cent).

Following surgery and postoperative orthoptic training, heterophoria was present in 27 patients (32 per cent); heterophoria for distance and heterotropia for near in 3 (4 per cent); heterophoria for near and heterotropia for distance in 2 (2 per cent); heterotropia persisted in 47 (55 per cent); and there was no record of whether heterophoria or heterotropia was present in 6 (7 per cent).

Group 3. This group with orthoptic training before and after operation includes 89 patients. Prior to treatment, third grade binocular vision existed in 6 patients (7 per cent); second grade binocular vision in 25 (28 per cent); and first grade binocular vision in 7 (8 per cent). Suppression, diplopia, alternation, and abnormal retinal correspondence, respectively, were present in 28 patients (31 per cent). There was no record of the grade of binocular vision in 23 patients (26 per cent).

Following pre-operative and postoperative orthoptic training, third grade binocular vision was present in 36 of these patients (41 per cent); second grade binocular vision in 26 (29 per cent); and first grade binocular vision in 3 (3 per cent). Abnormal retinal correspondence, suppression, diplopia, and alternation, respectively, were present in 15 patients (17 per cent). The grade of binocular vision was not recorded in 9 (10 per cent).

Following surgery and pre-operative and postoperative orthoptic training, heterophoria was present in 43 patients (49 per cent); heterophoria for distance and heterotropia for near in 3 (3 per cent); heterophoria for near and heterotropia for distance in 3 (3 per cent); heterotropia persisted in 37 (42 per cent); and there was no record of whether heterophoria or heterotropia was present in 3 (3 per cent).

*Alternating squint.* Sixty-seven of the 223 patients with strabismus had alternating esotropia or exotropia. Following orthoptic and surgical treatment, 27 (40 per cent) had third grade binocular vision; 18 (27 per cent) had second grade binocular vision; and 2 (3 per cent) had first grade binocular vision. Twelve (18 per cent) had no single binocular vision and in 8 (12 per cent) the grade of binocular vision was not recorded. Therefore, 47 patients (70 per cent) with alternating esotropia or exotropia developed some degree of binocular vision.

Nine patients with alternating squint were tested for aniseikonia. Six of these patients apparently had aniseikonia. Of this number, two are not wearing their lenses for cosmetic reasons, another has not obtained the iseikonic lenses, and iseikonic correction apparently caused nausea, vomiting, and marked discomfort in another patient. One patient is able to fuse for distance and near; she also is now able to knit and read with comfort. Another patient apparently fused more easily with the iseikonic correction.

*Amblyopia.* In a tabulation of 85 patients with amblyopia, 57 patients were included in group 1 (ages, up to 8 years; average age, 6). Of this number vision improved in 36 amblyopic eyes, 63 per cent; a reduction in vision occurred in 5 eyes, 9 per cent; and vision remained the same in 16 eyes, 28 per cent. In group 2 (ages, 9 to 12 years, inclusive; average age, 10) 18 patients were tabulated. Improvement in vision occurred in 12 eyes (67 per cent) and remained unimproved in 6 eyes, 33 per cent. In group 3 (ages, 13 to 21 years; average age, 15) of 10 patients vision improved in 5 eyes, 50 per cent; loss of vision occurred in 3, 30 per cent; and vision remained the same in 2, 20 per cent.

The largest number of amblyopic patients whose vision was improved occurred between the ages of 9 and 12; the next largest number was found in patients up to 8 years of age and the lowest percentage occurred in the third group between the ages of 13 and 21. Although I believe that amblyopia should receive early treatment, especially because of the importance of adequate visual acuity in the development of normal binocular vision, more satisfactory results sometimes may be obtained with older than with younger patients because of the willingness of the former to co-operate.

### ANALYSIS OF STATISTICAL DATA

In order to compare the results obtained from the surgical treatment of strabismus and from the combined surgical and orthoptic treatment, group 1 is compared with the combined totals of groups 2 and 3. In group 1, consisting of 49 patients treated with surgery only, after operation 3 patients, 6 per cent, became heterophoric while heterotropia persisted in 46, 94 per cent. The findings in groups 2 and 3 indicate that following surgery and orthoptic training heterophoria was present in 70 patients, 40 per cent; heterophoria for distance and heterotropia for near in 6 patients, 4 per cent; heterophoria for near and heterotropia for distance in 5 patients, 3 per cent; heterotropia persisted in 84 patients, 48 per cent; and there was no record of whether heterophoria or heterotropia was present in 9 patients, 5 per cent. The findings of groups 1 and 2 combined—174 patients—also show that, following surgery and orthoptic training, third grade binocular vision was present in 65, 38 per cent; second grade binocular vision in 42, 24 per cent; and first grade binocular vision in 10, 5 per cent. Therefore, 116, 67 per cent, had some degree of binocular vision following treatment. Thirty-seven, 21 per cent, did not have single binocular vision and there was no record of the grade of binocular vision in 20, 12 per cent.

The reason that poorer results are obtained with those patients who are operated upon and receive no orthoptic training than with those who are given postoperative orthoptic training possibly may be attributed to the lack of orthoptic training. It has been my experience that, unless true projection takes place before operation, the same degree of deviation which existed prior to intervention may recur. This result is noted especially in those patients whose most spasmodic muscle or muscles were not weakened, because they will attempt to place the image on the abnormally corresponding area of the retina and will have the power to do this. Nevertheless, in certain cases in which normal retinal correspondence could not be developed before operation, it was found that operation followed by continuous orthoptic training was apparently of benefit in producing normal retinal correspondence.

Aniseikonia may be a factor in some cases in which fusion cannot be developed.

### SUMMARY AND CONCLUSIONS

1. Of 49 patients with varying degrees of esotropia and exotropia, who received no orthoptic training before or after operation, only 6 per cent became heterophoric after operation. Heterotropia persisted in 94 per cent of the patients.

2. Of 85 patients with varying degrees of esotropia and exotropia who were given orthoptic training after operation, heterophoria was present in 32 per cent and some degree of binocular vision was found in 61 per cent.

3. Of 89 patients with varying degrees of esotropia and exotropia, who received orthoptic training before and after operation, heterophoria was present in 49 per cent and 73 per cent had some degree of binocular vision.

4. Forty-seven, 70 per cent, of 67 patients with alternating esotropia or exotropia developed some degree of binocular vision.

5. That orthoptic training may be important in the development of normal retinal correspondence after operation is suggested by the fact that 25 per cent of 126 patients with heterotropia had false projection, and following orthoptic training the number was reduced to 10 per cent.

6. Correction of aniseikonia seemed to be a factor in aiding fusion in 2 of 6 patients with alternating esotropia.

7. Of 85 patients with amblyopia, improvement in vision apparently occurred in 53 eyes, 62 per cent.

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## Discussion

Dr. Luther C. Peter, Philadelphia: After years of effort to awaken the profession to the great possibilities, first, of restoring vision in amblyopia ex anopsia in concomitant squint, and, second, in the development of true single binocular vision, it is refreshing to read the papers of Bressler[1] and of Hicks and Hosford[2]. The gathering together of data which can be reduced to statistical form is time consuming but is quite forceful in convincing many who are not impressed with the equally authoritative presentation of the same facts gathered from clinical observations and deductions.

The manner in which Dr. Berens has arranged his three groups with the logical conclusions to be drawn from them is corroborative of the fact that if the entire subject of squint is approached systematically, thoroughness in each step will eventually yield re-

[1] Bressler, J. L. Treatment of strabismus; influence of orthoptic training on results of operation. Arch. Ophth., 1936, 16: 433.
[2] Hicks, A. M., and Hosford, G. N. Orthoptic treatment of squint. Arch. Ophth., 1935, 13: 1026.

sults, far in excess of the excellent percentage of cures recorded in the third group of cases.

My experience is fully in accord with most of the basic principles so well expressed by the essayist. Several phases will bear elaboration. In my practice, aside from lack of co-operation of parents and child, which is really embodied in the two great obstacles in the way of perfect cures with true stereoscopic vision, amblyopia and suppression are the two elements which call for special stress. If one reaches a point in orthoptic training when no further improvement in the deviation can be obtained (a period of 3 to 6 months being a reasonable period in which to determine this), one should at once proceed to operative measures. As Dr. Berens has pointed out, these measures should be selected for the individual needs of each patient and they should be continued in steps until parallelism is really obtained. After operative procedures, orthoptic training, in those cases which require operation, will complete the cure in a relatively short time, provided amblyopia is fully corrected and suppression is finally overcome.

It must be evident to all that these two obstacles, amblyopia and suppression, become increasingly difficult to overcome with each added year after seven, because both are acquired habits, the former being the outgrowth of suppression. The longer the habit is in existence the greater is the difficulty of its correction. In the overcoming of this habit, the synoptophore is an essential.

One hears many references to false projection as the result of non-corresponding retinal points. In my experience, this is of comparatively rare occurrence, if the technician is alert in her work and if special attention is paid to suppression and amblyopia. It is also due, in part, to a lack of care in the selection by the technician of suitable cards on the synoptophore and the stereoscope. At the beginning of training all fusion cards should be large enough to include the fusion areas beyond the macula, so as not to tax too greatly macular vision which may not be acute.

The association of disparate retinal points, in this condition, is not unlike the false projection observed in paralytic squint, but unlike paralytic disparity, in concomitant squint, although it is also a psychic or mental act, the habit grows and is not so easily overcome. It, however, is amenable to treatment.

The tendency to residual heterophoria uncovered by any one of the several muscle balance tests, while both eyes respond normally to fusion tests, is not the result of false projection, or the desire to revert to the use of disparate retinal points, but it is evidence that, whether with surgery or without, the fusion gap is too great for any critical test. In this reversion, suppression, which is easily pressed into service, comes to the patient's rescue. Under these circumstances the surgeon has recourse to one of two methods. Either orthoptic training should be intensified, especially on the synoptophore, or it should be carried out for a longer period on the stereoscope, the latter involving months of constant training, or surgery should be called upon to correct the defect. If no operation has been performed, it is indicated and should be directed, as Dr. Berens has pointed out, to the overacting muscle or group of muscles. If surgery has been practiced, further procedures are indicated so as to reduce the fusion gap which can easily be bridged by the fusion faculty at all times. I have seen many cases restored to almost normal muscle balance by long continued training, but I believe that surgery is the better and more efficient method of meeting this condition. A residual heterophoria may be inconsequential to a child, but such residual heterophoria will be trying upon the adult when the eyes may be called upon to work for many hours at the near point. Furthermore, even in childhood as in adolescence and in adult life, one cannot be sure but that many overwrought nervous systems are predicated upon an ocular muscle imbalance.

We have reached a stage in the management of squint, when we should no longer be contented with cosmetic cures. Real cures are within the reach of all, but they can be obtained only by a carefully planned program adapted to the vagaries of each individual case. I need but refer to the three groups of cases presented by the essayist to convince anyone who is eager to improve his results, that each step in the treatment of squint is but a part of a well conceived plan and that each part of the plan demands meticulous care.

For this reason it seems to me to be timely to call the ophthalmologist's attention to the fact that he should be versed in the refinements of each phase of the treatment. The lay technician, when properly supervised, is of wonderful assistance in the orthoptic training of squint; she has infinite patience and skill in the handling of children, but all the orthoptic training should be prescribed by the physician as he prescribes for suitable glasses and performs the necessary operations. He must be the directing head of each phase of the treatments if he hopes to obtain the best results in squint.

There is no greater field open to the young ophthalmologists of today than the correct treatment of squint.

# PRENATAL MEDICATION AND ITS RELATION TO THE FETAL EAR

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THE presence of deafness at birth does not necessarily indicate that the condition is due to some hereditary defect, for it may result from injury to the organ of hearing in the course of the child's intra-uterine life. This type of deafness should, therefore, be classified as deafness acquired *in utero* and not as hereditary deafness. The study of the prevention of deafness should, then, begin with the prenatal life of the child, which would also necessarily include the proper care of the expectant mother.

For many years the otologist has recognized that certain drugs have a selective action for the auditory apparatus and can cause a nerve deafness, and that the eighth nerve is more often affected by drugs circulating in the blood stream than any other of the nerves of special sense. Quinine, the salicylates, and alcohol are known to cause degenerative changes in the delicate mechanism of the ear. Degeneration atrophy of the ganglion cells and nerve fibers in the basal coil of the cochlea, as a result of the administration of quinine, has been observed and similar changes in the lamina spiralis have also been noted.

The use of various drugs has shown that many persons have a marked idiosyncrasy for them. After taking small doses of quinine, many individuals show pronounced symptoms, such as cutaneous eruptions, a rise in temperature, marked tinnitus, and deafness. Likewise, others are highly sensitive to the action of the salicylates and on taking them may develop a slow, weak pulse, a subnormal temperature, dyspnea, dimness of vision, hissing and roaring sounds in the ears, and deafness. These reactions seem to be purely individual in many cases and without consequence, so far as the offspring is concerned. A cursory review of the literature, however, disclosed reports of 22 cases of fetal death attributed to the toxic effect of quinine administered during labor, and they contained repeated references to the idiosyncrasy of the mother for this drug.

In a recent article Wittmaack stated that his further experiments with quinine poisoning, especially with chronic poisoning by prolonged administration, have confirmed his earlier conclusion that quinine has a definite toxic action on the ganglion cells of the cochlea and the associated nerve fibers. This drug, he concluded, acts upon the ganglion cells as a protoplasmic poison, and his findings indicate that the cells of the cochlear ganglia are especially susceptible to injury by quinine, more so than those of the vestibular ganglia or of other cranial nerve ganglia. It was Wittmaack's belief that quinine induces a hypotonia of the labyrinth, a diminution in the endolymphatic pressure with resulting collapse of the membrana Corti. Haike reported that the permanent deafness which sometimes occurs after the use of salicylates is due to the irreparable injury to, and the destruction of, the spiral ganglion cells. Klugkist stated that deafness caused by alcohol is due to injury of the hair cells of the organ of Corti, the injury being most marked at the basal turn of the cochlea.

At the present time otologists cannot agree as to the exact location or the physiology of the so called cortical center of hearing; neither are they positive as to what effect drugs that cause deafness may have on this center. The literature is replete with reports of the finding of quinine in concentration in the brain. My interest in this subject led me to look for this alkaloid in the cerebrospinal fluid to determine whether the choroid plexus is permeable to it. Dr. L. Y. Dyrenforth, in collaboration with me, recently did spinal punctures on three subjects who had been given 30 grains of quinine by mouth. In 2 of the 3 cases he found the drug present in the cerebrospinal fluid. In 1926, Loberg reported that sodium salicylate, given to normal individuals in doses of 6 grams daily for 6 days, was regularly found in the cerebrospinal fluid. Bernard and Daniel, in 1933, reported that sodium salicylate, when given by mouth, could be found in the cerebrospinal fluid. Walter, Newman and Mehrteus, Schumm and Fleishmann, and Abramson and Linde reported that alcohol, after administration by mouth or injection, is found in the cerebrospinal fluid. Opinions differ as to whether the alcohol is secreted by the choroid plexus and diffuses slowly down the cord, or whether the process is a simple transudation from the blood vessels.

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Otologists seem to agree that deafness caused by quinine is due to the contraction of the blood vessels of the internal ear, the resulting ischemia, lack of nutrition and anoxemia causing degeneration of the ganglion spiralis and the organ of Corti. However, the presence in the cerebrospinal fluid of quinine, which is known to be a protoplasmic poison, is not without clinical interest and its importance has not yet been evaluated. It would be interesting to determine whether the stria vascularis, which secretes the endolymph, may not be analogous to the choroid plexus, which secretes the cerebrospinal fluid, and whether quinine may not find its way directly into the ductus endolymphaticus and bathe the hair cells of the organ of Corti.

Until recently the otologist has given little consideration to the fact that drugs administered to the pregnant woman pass through the placenta and are found in relatively large amounts in the fetal circulation. The use of twilight sleep furnishes ample evidence that the fetal tissues react to drugs in the same manner as the maternal tissues. For this reason its use has been largely abandoned in the practice of obstetrics, owing to the respiratory depression of the newborn child. Numerous cases of congenital morphinism furnish further evidence that drugs pass from the mother to the child through the placenta. Pettey found that the newborn baby of a mother who is an addict to morphine or opium is as much an addict as the mother, for the child's blood and tissues are as fully saturated with the narcotic as are hers. He stated that every child born of a mother using opium should be given an opiate for the first 3 days after birth and appropriately treated for narcotism thereafter. Burnett also stressed the importance of treating newborn infants for morphinism and other narcotism. Severance of the placental circulation through which the child has been receiving the narcotic shuts off the supply, and the shock and collapse incident to the abrupt withdrawal of opiates from an addict follow if the drug is not administered.

Quinine, the salicylates, and alcohol, which cause nerve deafness, also pass through the placenta and are found in relatively the same strength in the fetal circulation as in the maternal circulation. Regnier stated that quinine was found in the blood and all the organs examined, including the brain, of a human fetus of 4½ months, 40 hours after the mother had taken 1.50 grams of quinine sulphate. He further stated that the concentration was comparatively high in the blood, and higher in the brain than in the liver. In a case which resulted in a fetal death from quinine given the mother, King found appreciable quantities of the drug both in the brain and in the urine of the fetus.

Quinine, the chief drug causing nerve deafness, was found in the urine of 16 of the 17 babies examined by Dilling and Gemmel after it had been given the mothers to induce labor. They reported finding the drug in the urine of the fetus 6 to 12 hours after the last dose was administered to the mother and observed that a concentration of quinine which may be toxic to the fetal tissues may persist in the fetus many hours after the wave of secretion in the maternal urine has subsided.

Sodium salicylate, which is known to affect the ear, was found by Porak in the urine of infants when it had been given to the mother 30 minutes before delivery and it continued to be present for as long as 3 days, the concentration being greater several hours after birth than at birth. Nicloux asserted that the placenta acts as a dialyzer of drugs present in the maternal blood and stated that crystalloid substances, such as quinine and the salicylates, pass through the epithelium of the placental villi and are found in the fetal circulation in relatively the same strength as in the maternal circulation. In his experiments on women in labor, he gave alcohol in milk an hour before delivery of the child. This drug was demonstrated in the blood of the umbilical cord in practically the same concentration as in the maternal blood.

The cases diagnosed as deafness acquired *in utero* as the result of prenatal medication, which have come to my attention, fall into three groups: (1) those in which quinine was used therapeutically in diseases concurrent with pregnancy; (2) those in which quinine was used in unsuccessful attempts to produce abortion; and (3) those in which quinine was used in the induction of labor. In none of the cases I now present was there a family history of deafness or consanguinity. In all, the ear drum showed the usual light reflex with no retraction and no displacement of the umbo. Cases 2 and 3, which have previously been reported, were under the care of Dr. Charles C. Grace and the patients were inmates of the State School for the Deaf and Blind at St. Augustine, Florida.

### CASE REPORTS

CASE 1. S. N., a boy, aged 5 years, apparently had no hearing. Otherwise aural examination was negative. He had 3 brothers, all of whom had normal hearing. The mother, when 7 months pregnant, was given 30 grains of quinine intravenously for the treatment of malaria.

Within 3 hours she developed urticaria, tinnitus, and a severe deafness. Her hearing after 5 years had not returned to normal.

CASE 2. H. McL., a girl, aged 15 years, had no hearing so far as could be determined. The hearing of her 2 brothers and her sister was normal. The mother had typhoid fever when about 12 years of age and "was given quinine to break the fever." She became extremely deaf and remained so for the duration of the fever, a period of 3 or 4 weeks. Several times afterward she took quinine for colds and each time a small dose produced intense ringing in her ears and partial deafness. During the eighth month of her pregnancy with the deaf child she was treated for influenza with large doses of quinine, given over a period of 24 hours. Pronounced deafness resulted and the drug was therefore discontinued. She took no quinine during her other terms of pregnancy. At birth the child was apparently normal in every way and grew and developed without serious illness or accident. Her deafness was recognized when she was about 18 months of age.

CASE 3. J. D., a boy, aged 5 years and a first child, was without hearing so far as could be detected. The mother stated that when she was 4½ months advanced in pregnancy, she developed a tertian malaria and was immediately started on quinine therapy according to the Bass method of treatment. After taking 30 grains a day for 5 or 6 days, she became so deaf that it was necessary to lean over her bed and shout into her ear in order to make her hear. Since that time she had taken small doses of quinine in the home treatment of colds and each time a very small amount of the drug had produced a severe tinnitus and some loss of hearing. From birth the child had never given any evidence of hearing.

CASE 4. T. A., a girl, aged 5 years, had no hearing so far as could be determined. Her 3 sisters had normal hearing. Aural examination showed a normal ear drum with the usual light reflex with no displacement of the malleus or umbo. The mother stated that when she was 4½ months pregnant she attempted to produce an abortion by taking 50 grains of quinine, an expedient which failed to effect the desired miscarriage. She developed a tinnitus and deafness which, after 5 years, had not disappeared. At the time I examined her five year old child she inquired if the quinine which she had taken to produce the abortion could have been responsible for the deafness of her child.

CASE 5. W. J., a boy, aged 3½ years, appeared to be completely deaf. He had 2 brothers whose hearing was normal. The Wassermann examination was negative. The mother stated that about 6 and 8 hours before the delivery of this child she had taken two capsules of quinine. Her hearing was affected at the time and she still had diminished hearing for high notes.

These cases deal with only a marked degree of deafness. Deafness acquired *in utero* may manifest itself as merely a diminution in the function of hearing and not necessarily as complete deafness. When a patient shows no deformities, gives normal vestibular reactions to the whirling and caloric tests, has a family history without record of deafness and consanquinity, but shows partial deafness with tone gaps or islands of deafness, or apparently complete deafness, information regarding drugs used in prenatal medication is seemingly of particular interest. If the otologist in obtaining the history of each child showing a nerve deafness will take care to include in the usual questionnaire the history of drugs administered to the mother during her term of pregnancy, the etiology of a number of perplexing and otherwise unexplained cases of nerve deafness may be solved.

Leroux and Tilloy, in a study of 25 deaf mutes, cited the case of a child whose deafness was attributed to the fact that the mother had sciatica and the child was made deaf by the action of toxins in the mother's blood that were not eliminated. These authors gave no consideration to the fact that the mother might have been given massive doses of the salicylates or quinine and that the child may have been deafened by these drugs reaching the fetal ear through the placental circulation. The idea of prenatal medication and its relationship to the fetal ear was in this case doubtless ignored. Such instances occur in profusion in the literature.

It is worthy of note that recent investigators have found congenital syphilis only a minor causative factor of deafness. McCarty concluded that there is no proof of an abnormal tendency to deafness in this disease. The report of the committee on statistical studies of children in public schools for the deaf, made to the National Research Council, stated that 62.15 per cent of the 5,348 deaf children examined by it were classified as congenitally deaf and also stated that congenital syphilis plays only a small part as an etiological factor of deafness.

Of profound interest are the recent observations of Covell, which pertain to cytological alterations following the administration of quinine and the salicylates to animals. He found that quinine bisulphate and sodium salicylate produce mitochondrial changes in the cells of the stria vascularis and in the sensory cells of the organ of Corti. He observed that the spiral ganglion cells after treatment with sodium salicylate exhibit a greater degree of change than after administration of quinine, but that quinine produces more profound lesions, as described for the stria vascularis and the hair cells of the organ of Corti. From experiments on pregnant guinea pigs he concluded that "the cochleæ of the fetal guinea pig's ears exhibit similar but more profound changes than those of the adult animal."

The otologist has not the advantage in studying the ear that the ophthalmologist has in studying the eye. With the ophthalmoscope the ophthalmologist can observe the pallor of the nerve head and the marked contraction of the retinal vessels, and with perimetric examinations he can outline the contraction of the visual field and scotoma. The otologist has no such ad-

vantage in studying the damage to the ear from drugs which cause nerve deafness. Examination of the fundus of the ear is of little value in the study of nerve deafness. The source of information is from functional testing with the tuning fork, the Galton whistle, and the audiometer. Diagnosis is made with difficulty before the child is in his third year, and this delay may explain why deafness as a result of prenatal medication has escaped the attention of the otologist. Surely the history of every child with nerve deafness should no longer be considered complete without a history of the mother which includes a record of the intake of drugs during the term of pregnancy.

SUMMARY

Idiosyncrasy for drugs that have a predilection for the auditory nerve, such as quinine, the salicylates, and alcohol, may be an important factor in causing nerve deafness.

The drugs that cause this type of deafness readily permeate the placenta and, passing into the fetal circulation, may be toxic to the fetus.

Quinine, the chief drug that causes nerve deafness, is frequently used to induce labor and in the treatment of disease concurrent with pregnancy.

The action of quinine, the salicylates, and alcohol on the fetal ear may be an etiological factor of deafness in the newborn.

The relation of prenatal medication to the fetal ear is of sufficient importance to invite continued investigation both clinically and experimentally.

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## Discussion

Dr. James A. Babbitt, Philadelphia: Dr. Taylor's presentation is impressive and convincing. He carries the study of the well known otologic influence of quinine, salicylates, and other drugs into the field of prenatal influence. It is very evident that placental circulatory transmission takes place, certain elements appear in the spinal fluid, and certain degenerative changes may occur in the cochlear structures, notably the stria vascularis, sensory cells of Corti's organ, and the spiral ganglion cells.

It is difficult to measure conclusions with scientific accuracy as final pathological analysis may destroy the exact mitochondrial transition in the structures about Corti's organ. Note Covell's statement upon this: "The effects of various toxic agents such as drugs, poisons and toxins, on the mechanism of hearing, are more readily studied by tests of hearing than by examination of sections of the cochlea for pathological changes."

Another difficulty rests in the limitation of accu-

rate hearing tests at a sufficiently early age to guarantee prenatal influence, although investigators are making progress by studying the results of stimulation by frequencies of high intensity.

There is a delightful analogy in this study of prenatal deafness from drugs and toxins to the problems of otosclerosis of familial origin and the Wittmaack school deductions of the effect of various types of infantile otitis on the pneumatization of the mastoid process. The addition of "prenatal preventive medicine" might make this an interesting triad.

Certain questions suggest themselves: first, as to primary hemorrhagic or ischemic sequence in the cochlear changes; second, as to the persistent predilection for involvement of the basic whorl of the cochlea; third, as to the possible value of experimental spinal injections of quinine, salicylates, alcohol, and barbiturates; fourth, as to paucity of report on alcoholic influence in deafness; fifth, as to why there is not more vestibular reaction to quinine and the salicylates inasmuch as the arterial supply of the basic turn of the cochlea and the vertical semicircular canal seem so related; sixth, as to the probable interrelation of the otological problem of tinnitus aurium.

The College and its members are under deep obligation to Dr. Taylor for his altruistic service in these earnest and careful investigations.

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# OPHTHALMOLOGICAL FINDINGS IN CARDIOVASCULAR RENAL DISEASE

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THE results of the study of the vessels of the retina and choroid with the ophthalmoscope are of distinct value in the diagnosis and prognosis of diseases of the arterial system, the heart, and the kidney. Competent authorities differ as to the exact diagnostic and prognostic portent of the ophthalmoscopic findings, but of their value all are agreed.

We have much to learn as to the application of the knowledge we have gathered. It is being evaluated more exactly, however, as accumulation of this knowledge takes place from the competent observations of many workers. As Osler observed in his Harveyian oration, "The Growth of Man," "It is slow, often of difficult growth, marked by failures and frailties."

## ARTERIOSCLEROSIS AND ARTERIAL HYPERTENSION

The alert ophthalmologist is frequently the first to diagnose early arterial disease. The public is well informed concerning the cause of headache as often being due to eyestrain. The patient consequently may consult the ophthalmologist before he does his physician. The headache and asthenopia may be due to vascular disease and not to eyestrain. I do not speak at this moment of advanced hypertensive disease or arteriosclerosis. I refer to incipient disease of this nature in which the diagnosis may often be suspected by the ophthalmologist. Many such patients can be cured or the disease arrested. Careful study of the retina and its vessels will reveal the nature of the disturbance and hence result in the prolongation of the activities and the lives of many. I believe I am correct in thinking the manifestations of vascular disease may very often be observed by the ophthalmologist before such manifestations are discernible by the internist.

Ophthalmological findings are of particular value to the internist, the neurologist, and the neurological surgeon. Indeed, to evaluate such findings properly the ophthalmologist must of necessity keep himself informed of the rapid advance in the knowledge of these major divisions of our art. The unknown toxins causing arterial hypertension probably attack by predilection the carotid system as the luetic toxins do the aorta. This is why the hyperpietic patient is more prone to hemorrhage in his head than in other parts of his body.

Does the hypertension precede the organic changes in the vessels or are the vessels, particularly those of the capillary system, first involved? Where is the beginning of this destructive process? Much intensive observation and fascinating study are to be made in this field. The ophthalmologist may be of much assistance to the internist and the pathologist in the search for the truth. The study of the fundus should be made in a dark room with the pupil dilated.

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More than one sitting is frequently necessary. The retinal vessels are minute and careful study will show early pathological changes in their walls. Red free light is of value in observing fine perivascular changes. The intensity of the light should be increased and decreased to bring out the finer changes in the vessel walls. Each vessel should be studied with care, particularly the smallest arteries about the macula.

While refracting the eyes, a characteristic reaction has been noted. I have called this the "arteriosclerotic reaction." There is alternate brightening and dimming of the test letters; the patient is unable to distinguish between lenses of different strengths, sometimes as much as one diopter. At times it is impossible to do a subjective refraction. Such patients frequently suffer from severe asthenopia, being unable to use their eyes for near work for any length of time without pain and discomfort. They will volunteer the information that they see very well at one time and poorly at another. This reaction resembles that seen in neurotic cases and care must be taken to distinguish between them. This can be done by study of the retina and the retinal arterioles. The Friedenwald ophthalmoscope lends itself particularly well to this study because of the slit and the strong light without shadows or reflexes.

The arteriosclerotic reaction is particularly marked in those cases in which there is a faint haze in the retina. This haze is difficult to see because of its faintness. There is a dimming of the brilliancy of the whole fundus rather than an actual cloudiness. One might compare it with the dimming of the brilliancy of a tropical sky preceding a typhoon. There is no perceptible haze, no cloud, and yet the brilliant sun and deep blue sky are not as brilliant as they were a short time ago. Associated with this faint clouding of the retina are slight but manifest abnormalities in the arterioles of the retina. The translucency of their walls is less. There is corkscrewing of the vessels about the macula and there are slight changes in the color of the vessels. The arterial tension is likely to be increased, but it may be slight and confined to elevation of the diastolic pressure. Examination by a competent internist will probably give no abnormal findings. If such patients are observed over a period of time, the progress of vascular disease is seen to continue slowly until, after several years, varying greatly in different individuals, the major signs of hypertension and arteriosclerosis will appear. One may not secure enthusiastic co-operation on the part of the internist since the latter does not observe in his examination evidence of vascular or renal disease. My observation has been, however, that we may look upon such persons as being in the prehypertensive stage of their disease. If the cause is carefully sought for and can be removed, the retinal signs will disappear together with the headache and asthenopia.

This class of patients is often seen in those between 40 and 50 years of age who are living and working hard and fast. They are likely to be vigorous and full blooded, to eat heartily, smoke furiously, use much coffee, and rest but little. As before mentioned, an examination by the internist reveals nothing abnormal and he pronounces them fit.

Quite a different picture is seen in individuals with well developed changes in the retina and retinal vessels. Such patients are likely to be beyond the fifth decade.

The retinal arteries show caliber variations, beading, color changes, accentuation of the light streak, and arteriovenous compression. In extreme constriction there may be disappearance of the light streak and increased visibility of the vessel walls. Increased tortuosity and fullness of the main retinal vessels may be noted.

According to Friedenwald, branches of the central artery of the retina of the first and second order may be designated as arteries, those smaller as arterioles. Other writers consider all retinal arteries as arterioles. They have thin arterial walls and absence or slight development of the muscular coat.

Variations in caliber are seen chiefly in the larger branches, those of the first and second order. This is due to atheroma. The central artery of the retina within the optic nerve and before it enters the nerve is likely to be affected with this form of sclerotic change. Such changes are analogous in appearance to similar changes occurring in the arteries throughout the body. Tortuosity and arteriovenous constriction are the least reliable evidences of pathological changes in the retinal vessels. One should not rely on these changes alone.

Associated with disease of the retinal arteries are disturbances of the retina itself: hemorrhages which may be linear or flame shaped, together with "hard" or cotton wool white patches, and edema of varying intensities, or, in other words, a hypertensive retinitis or retinopathy. The vascular tension is probably high; the kidneys may or may not be involved.

By some writers the cause of this retinal condition is thought to be an ischemia produced by arterial spasm. Other writers believe that it is

brought about by a toxin which is the cause of the arterial spasm, the retinitis, and the final renal involvement. Much study is yet necessary before we may understand the underlying cause of this complex picture. If we so perfect our methods and appliances that a study of the retinal capillary bed can be made, we may be able to determine where the primary damage is inflicted.

The appearance of retinitis is ominous in hypertension, yet it is my observation that it is not necessarily of fatal import. I saw only a few days ago a patient now 65 years of age who developed a hypertensive retinitis 10 years ago, which subsided slowly, damaging the vision but slightly. He has continued at his work in a government department and looks forward to retiring at 70 years of age. He is vigorous and strong beyond the ordinary man of his years, at this writing. One sees many such cases and yet retinitis is a symptom we dislike to see appear, since in the majority of patients it presages the advent of serious developments.

The group designated by Fishberg (quoted by Friedenwald) as arteriosclerotic angiopathy includes those retinal lesions with little or no papillary involvement. There are hemorrhages of various sizes and shapes with small "hard" white spots in the retina and marked arteriola sclerosis. Other terms used for this condition are angiosclerotic or arteriosclerotic retinitis. He designates as hypertensive neuroretinitis the following: hyperemia of the disc or indistinct margins of the disc, arteriola changes, retinal hemorrhages, hard white spots, and cotton wool patches in the retina. This form of retinal involvement has been termed renal, nephritic, or albuminuric retinitis. Attempts have been made to divide it into various subdivisions. This is difficult since arteriosclerotic retinopathy and hypertensive neuroretinopathy may show both types of lesions. It would seem unnecessary and confusing to give different names to a condition which varies its ophthalmological picture in different stages. The lesion results first from vascular damage, caused, in turn, by hypertension, and further from retinal damage from advanced vascular disease in which the kidney is involved. The etiological background may be reversed in some cases in that disease of the kidney may be the original lesion, the vascular involvement following. In kidney disease, retinitis may be present in a higher percentage than in those having primarily hypertensive vascular disease.

I am in agreement with Cannady and O'Hare that it is not possible to tell from the retinal findings whether the case is one of renal or non-renal disease and that there is no distinctive type of retinal lesion accompanying chronic glomerular nephritis. I am further in accord with them that the fundi in hypertension or malignant hypertension can not be differentiated from the fundi in glomerular nephritis and that the different pictures presented in the retinopathies are but stages in the development of a retinitis. It is apparently the consensus that arterial hypertension precedes vascular disease. However, one rarely sees patients in whom no arterial hypertension can be demonstrated, yet who show well marked arteriola disease and retinal changes of a low grade type.

A rarer type of retinal change consists of a slight but well marked retinal edema in those about the age of 65 or 70. Such patients may be exceedingly well preserved, vigorous, and leading active business lives filled with heavy responsibility. With no warning their vision suddenly dims and upon examination a slight retinal clouding is noted, particularly at the macula. The vision which was normal has fallen to 20/40 or thereabout. A medical survey reveals a well preserved person of 70 years of age. The impaired vision lasts a few days and disappears to return again after a week or so. It is an ominous symptom and death may soon occur from a cardiac or vascular accident or perhaps sudden failure of renal function. Such cases are rarely seen but their ominous portent should not be overlooked. The retinal vessels show no evidence of vascular hypertension or advanced vascular disease.

Yater observes that in the "fluctuating" stage of hypertension there are rarely observable vascular changes. In the "fixed" stage, degenerative changes occur in the arterioles in all parts of the body more or less. At first the only change is a hypertrophy of the muscular coat of the arterioles, the kind of change which occurs in any muscular tissue subjected to excessive activity. Later there is fibrosis of the arteriola adventitia and media; and last, there may be intimal or subintimal fibrosis and hyalinization. With these changes the arteriolar lumina become progressively smaller. From time to time excessive spasm of the arterioles may be noted on ophthalmoscopic examination before and during the fixed stage. Not infrequently there develops a retinitis or neuroretinitis. These changes are probably due to excessive vasoconstriction with consequent reduction in the blood supply to the retina, resulting in rather acute partial ischemia and stasis. Hemorrhages into the retina occur, the blood coming from the capillaries; the hemorrhages are mainly due to capillary stasis. The white patches are from the same cause. The cotton wool patches are probably areas of superficial edema which may be

entirely absorbed. The "hard" patches are probably cystoid spaces containing exudates of lipoid material. The glistening white deposits occasionally seen about the macular region are principally fat and lipoids.

Neuroretinitis is more common in cases of very severe vascular disease in which impairment of the renal function is more likely to ensue. In most cases of severe essential hypertension in which neuroretinitis is present, death is due to general visceral failure. That is, there is simultaneous failure of all the vital organs due to severe generalized vasoconstriction, and the individual dies of this general failure before he has time to develop renal failure.

The onset of retinitis and neuroretinitis is probably due to a sudden increase in the degree of constriction of the arterioles. When vasoconstriction is slow and progressive they do not develop, but a sudden vascular spasm will bring them out.

To quote Yater: "I hold this belief because I have observed that retinitis and neuroretinitis are more common in so called hypertensive cases in which there is a sudden extreme rise in the blood pressure. After the hypertensive crisis subsides the retinitis may disappear leaving only those vascular changes which are permanent." He observes further:

> Aside from the renal infections and the so-called surgical diseases, there are 3 main types of kidney disease:
>
> 1. Diffuse glomerular nephritis, which is subdivided into acute, subacute and chronic forms, each of which presents a definite clinical picture and course.
>
> 2. Kidney disease characterized by tubular degeneration, the so-called nephroses. This group is subdivided into lipoid nephrosis, amyloid disease of the kidneys, nephrosis of pregnancy, and nephrosis associated with bichloride of mercury poisoning.
>
> 3. Degenerative diseases, the only important one being renal failure due to renal arteriosclerosis, the result of long continued essential hypertension.
>
> In the chronic form of glomerular nephritis and in the later stages of the subacute form, there is regularly a severe hypertension. Glomerular nephritis is probably a disease of the arterioles in general, as well as of the kidneys. Nephrosis does not involve the vessels generally.
>
> It is only in cases of renal disease with hypertension that we see retinitis and neuroretinitis, the fundamental cause of which is the same as in essential hypertension. Therefore, the retinal pictures of essential hypertension and renal disease with hypertension are indistinguishable. Neuroretinitis may be an early sign of renal *failure*. It does not occur, however, until late in the course of the kidney *disease*, so that it is really a sign of approaching death. The degree of renal failure must be great before it is seen.

The ophthalmoscope is of considerable value in the diagnosis of heart disease, particularly in those affections of the heart due to arterial hypertension, coronary sclerosis, and subacute bacterial endocarditis.

Yater and Wagner studied 137 cases of heart disease and reached the following conclusions: In 96 per cent of the cases due to hypertension alone there were characteristic changes in the retinal arterioles. Therefore in hypertensive heart disease the retinal examination is important and particularly so in those cases in which the blood pressure has returned to normal. In this type of case the retinal findings may constitute the final diagnostic criterion.

In 92 per cent of the cases of heart disease due mainly to coronary arteriosclerosis there were retinal vascular changes either of the hypertensive type or of the senile fibrosis type.

We should remember that about one-half of all the cases of hypertensive heart disease develop coronary arteriosclerosis. The conclusions were that retinal arteriosclerosis in the presence of heart disease means that the heart disease is due either to hypertension, coronary arteriosclerosis, or both, provided there is no specific evidence of other causes of the disease of the heart. If the retinal changes are of the type associated with decrescent arteriosclerosis and there is no clinical evidence of other cause of heart disease, it is probably due to coronary arteriosclerosis, without antecedent hypertension.

If neither type of vascular retinal change is present, the chances are against the heart disease being due to either hypertension or coronary arteriosclerosis.

The prognosis is rendered more grave by the presence of retinitis or neuroretinitis and an earlier death can be anticipated.

In subacute bacterial endocarditis the retinal findings are characteristic and consist of hemorrhages with white centers. When present they are a distinct aid in the diagnosis.

### THE RETINITIS OF PREGNANCY

Changes in the retinal arteries precede retinitis of pregnancy and are the local cause of it. The changes in the arterioles are primarily spastic, and the retinitis is therefore of the angiospastic type. Wagner observes that it is logical to assume that in hypertensive toxemia of pregnancy as in glomerular nephritis and essential hypertension among non-pregnant patients, lesions in the retinal arterioles and resultant lesions in the retina proper are to be interpreted as evidence of injury to the arteriola system. Changes in the retinal arterioles may be organic (sclerotic), spastic, organic and spastic, or spastic followed by organic. If organic changes are present in the arterioles at the first examination in the early phases of toxemia, it is obvious that the patient has suffered

previous injury to the arteriola system as a result of chronic nephritis or essential hypertension. If spastic changes are present or develop either alone or superimposed on organic changes, it is strongly suggestive that toxemia is causing an active arteriola lesion which, if not controlled, will result in retinitis and new or increased organic injury to the general arteriola system. Repeated examinations may be necessary to differentiate between spastic and organic changes.

The development of retinitis usually means organic injury to the retinal and systemic arterioles, hence the serious prognosis. Retinitis can occur in any type of toxemia in which arterial hypertension is a feature. The development of retinitis in any toxemia of pregnancy is due to injury to the vascular system.

*Retinitis should not be allowed to develop in the pregnant woman.* Repeated ophthalmoscopic examinations should be made to follow the development and course of the spastic lesions in the retinal arterioles. If the spastic lesions become more marked, termination of the pregnancy should be advised at the first indication of localized hemorrhage or of exudate into the retina. Wagener believes that the beginning of retinitis marks the onset of irreparable organic changes of the arterioles and that a few days' delay may result in considerable injury. The results of this injury may not become manifest for a period of years. As a result of the progressive disease produced in the kidneys and arteries, there will be a gradual failure of health. The life of the patient may be shortened many years. In many cases vision may be seriously impaired or lost, if the pregnancy is not terminated in time. A very great responsibility rests upon the consulting ophthalmologist in such cases, as to conservation of both life and vision.

## CONCLUSIONS

An extensive literature has accumulated on the subject under consideration. Nothing new has been discussed in this present writing but an endeavor has been made to emphasize certain conclusions that are agreed upon by the majority of ophthalmologists and internists. It is the endeavor of the writer to stimulate further interest and study in the underlying and antecedent causes of arterial hypertension and arteriosclerosis. The pathologist, the internist, the ophthalmologist, and possibly other scientists working in a group will be able to elucidate this problem in time. It is my firm belief that the ophthalmologist may be able to give data which will be of great advantage in the clarification of this problem. It is also my desire to accentuate the ability of the ophthalmologist to make the earliest diagnosis in the very beginning of hypertensive arterial disease. By so doing he can be of greater aid to the patient and to his physician. It does not seem that the internist is as yet fully alive to this fact, that the ophthalmologist can discern symptoms of arterial disease in advance of the internist. The value of the ophthalmologist's ability is obvious.

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## Discussion

Dr. A. G. Fewell, Philadelphia: The vast literature which has appeared upon this subject in the past 80 years is evidence of the great interest this study has had for the ophthalmologist. A great amount of knowledge has been gathered upon the pathological significance of these lesions, and certain conclusions are agreed upon by the majority of ophthalmologists and internists. However, there are many problems yet to be solved as there are wide differences of view concerning many of these conditions. To us as ophthalmologists these differences offer the opportunity to aid in the search for the causes and conditions which still baffle medical science.

Numerous vascular lesions and other conditions of the retina were described by the earlier observers, but the latter did not correlate these retinal changes with systemic lesions. The progress in medical investigation has changed many of our ideas toward diseases of the cardiovascular renal system and the associated ocular changes. All fundus examinations should be made in a darkened room with the pupil dilated, both ordinary and red free light being used. Such examinations should be made repeatedly and all alterations in the retinal arteries and arterioles carefully noted. Such changes include alteration of the light reflex or loss of translucency of the vessels. It is of great clinical significance when it is intense,

when it varies in different arterial branches, and when it is associated with other changes of the arteries. Reduction and alteration in the caliber of the retinal arteries are important signs often overlooked. The attenuated vessels are often straight and branch at an acute angle. Tortuosity of the vessels which must be differentiated from a congenital condition, corkscrew arteries (arteriolar sclerosis) which is best observed in the macular region, is an important early sign of vascular disease.

Attention is called to the differences of opinion between competent observers. Wagener states that "the retinitis of glomerular nephritis almost invariably arises without preceding retinal arteriosclerosis, while the retinitis of malignant hypertension is almost invariably superimposed on pre-existing sclerosis of retinal arterioles." Cannady and O'Hare, on the other hand, found early signs of arterial sclerosis preceding other retinal changes in most of their cases of chronic glomerular nephritis.

There is also a difference of opinion as to whether or not the fundi of malignant hypertension and glomerular nephritis can be differentiated. The discusser believes that this differentiation can be made. Arteriovenous constriction is a sign of considerable importance. Extreme grades are found only in eyes where there has been a long standing and severe arteriosclerosis. Where an artery crosses a vein, the latter is not only compressed but seems pushed aside, the artery crossing at a right angle. The constriction of the vein gives rise frequently to a swelling of the distal portion. The vein is often obscured due to a loss of transparency of the overlying artery.

The cause of retinal sclerosis is still undetermined. It occurs with or without hemorrhages, edema, exudates, optic neuritis, and atrophy.

A careful study of the condition of the retinal vessels gives us valuable information concerning the state of the cerebral vessels. Much work remains to be done. There is still a confusion of terms which should not exist. The truth can be arrived at only by the working together of the ophthalmologist and internist. This co-operation has not been too evident in the past.

# SURGERY AND MEDICINE IN THE TREATMENT OF GLAUCOMA

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ON December 22, 1936, it will be exactly 80 years since Albrecht von Graefe performed the first successful iridectomy for a patient suffering from acute glaucoma. Von Graefe did not have local anesthetics, electric lights, or an aseptic operating room service; neither did Columbus have the accouterments of the modern navigator. The one like the other made an astounding discovery because he dared.

More than four centuries have passed since Columbus discovered the new continent. Only four score years have passed since von Graefe found surgical relief for glaucoma, but the dates of these events will not be forgotten throughout the ages because they brought new hopes to humanity. Even the name of the first patient, Gause, was recorded in ophthalmic literature as were the names of the three tiny caravels, "Pinto," "Nina," and "Santa Maria" in the world's history.

Both medicine and surgery have contributed to the four score years of progress toward a better understanding and treatment of this baffling disease, glaucoma. If the contributions of surgery and medical research to the conquest of glaucoma were to be considered in a competitive sense and reported as are blows in a boxing match, the first round (1856–1876) must be given to surgery; the second round (1876–1896) might be declared a draw; the third round (1896–1916) would be awarded to surgery. In the last round (1916–1936) medical research manifestly has the advantage, though surgery is going strong.

Medical research was not impressive during the first round. Donders and Heinrich Mueller (1858), after examination of glaucomatous eyes, reported agglutination between the base of the iris and the posterior surface of the cornea, the normal iridocorneal angle being closed. Von Graefe observed that mydriatics were harmful in glaucoma and that eyes which happened to show cystoid scars after cataract operations remained soft. The significance of these facts was not realized until many years had passed.

Von Graefe continued almost daily to iridectomize eyes for glaucoma but wistfully expressed his regret, in the last paper before his untimely death at the age of 42 in 1870, that he had not been able to formulate any satisfactory explanation concerning the etiology of glaucoma or the favorable reaction after iridectomy.

Leber's studies on the interchange of intraocular fluids published in 1873 were the preface to the second period which began in 1876 when Laquer presented the report on the use of miotics in glaucoma. Knies (1876), Weber (1877), and Priestley Smith (1879) were leaders in the evaluation of the effect of miotics and of the anatomical relations of the intra-ocular structures, but every one of the great masters of ophthalmology was involved more or less in the controversy in which the last word has not yet been uttered. Snellen became a recognized spokesman for those who could not agree with Knies, that obstruction of the iridocorneal angle was the primary etiological factor in glaucoma, but more of this anon.

Ophthalmic surgeons throughout this period continued with rare unanimity to advocate and perform iridectomy in glaucoma. Miotics were only temporary stopgaps, but it became evident that iridectomy, at best, only delayed the inevitable loss of vision in simple chronic glaucoma and not infrequently the operation seemed actually to precipitate disaster. De Wecker demonstrated that prolapsed iris tissue might be an advantage if it resulted in a cystoid scar. Previously it had been regarded as evidence of faulty surgical technique.

A possible reason for the reduction of intraocular tension after iridectomy was suggested by an observation of Fuchs, who was perhaps the first to call attention to the fact that penetrating wounds of the iris often did not heal, but remained open and transmitted the fundus reflex on ophthalmoscopic examination. Fuchs made practical application of this observation with success in the relief of secondary glaucoma with iris bombé. The re-establishment or improvement in the intercommunication between the anterior and posterior chambers of the eye was accepted as a factor in the relief that had been obtained. Direct aspiration of the aqueous humor into the open veins of the unhealed wound of the iris may have been another factor.

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Transfixion of the iris in various directions was tried out subsequently for the relief of primary glaucoma, but results in primary glaucoma were not sufficiently certain or lasting to inspire much confidence in this operation. Elliot's subsequent criticism that "they accomplish nothing which could not be done more efficiently and without greater risk by iridectomy" probably expresses the general opinion of ophthalmic surgeons today.

The first decade of the twentieth century saw Elliot's trephining, La Grange's iridosclerectomy, Holth's iridencleisis, Borthen's iridotasis, and Heine's cyclodialysis presented and gaining recognition for their effectiveness in surgical relief of intra-ocular tension.

It is not necessary to describe these operations. They have become more or less familiar proceedings in every ophthalmic clinic and hospital throughout the world. They all involve an attack on the integrity of the iris or its anatomical relations. They differ much in execution but have the same general purpose, that is, to achieve adequate and, if possible, permanent extra-ocular drainage. With the exception of Heine's iridodialysis, they were the legitimate offspring of de Wecker's insistence on the benefits of a cystoid scar. Two of them represent deliberate attempts to secure transscleral filtration by entanglements of iris tissue in the subconjunctival wound. Even Heine's iridodialysis may owe some of its usefulness to the initial incision through the sclera

Experienced ophthalmic surgeons controlling some of the largest clinics have attempted to apply certain of these surgical methods to definite types of glaucoma, but no universally accepted rule for such selective discrimination has been established. Most ophthalmic surgeons seem to make their selections on the empirical basis of their own clinical experience. Probably the best results are achieved with the type of operation with which the operator has become most familiar and efficient.

Involuntarily the question is raised, "Does surgery cure glaucoma?" The answer can be no more than a conditional affirmative. Surgical operations for glaucoma with one exception are planned to overcome the retention of abnormal or excessive intra-ocular contents, the aqueous humor. Only Abadie's cervical sympathectomy was primarily directed at an assumed possible cause of glaucoma, but its failure as a cure and as a prophylactic is well known. Most operations may be, and not infrequently must be, repeated in the same eye when the first attempt has not been a success or the apparent initial success has not been maintained. A successful reduction of intra-ocular tension by surgical drainage can restore normal function to the organ of vision, but it is scarcely entitled even then to be designated as an actual cure of the disease.

My first personal contact with experimental therapeutic attempts to meet the problems of glaucoma by methods other than the simple use of miotics happened in the kindergarten days of my ophthalmic training through contact with A. E. Ewing and Greenfield Sluder. Ewing, in collaboration with Sluder, had demonstrated the tenderness at the area (Ewing's point) in the upper inner angle of the orbit which was found to be related to nasal obstruction or nasal sinus disease. Sluder had successfully relieved pain in such cases. Sluder's next step was the successful treatment of certain types of neuralgic pain by anesthesia or "blocking" of the sphenopalatine (Meckle's) ganglion. Ewing and Sluder then tried anesthesia of this ganglion for relief from glaucomatous pain with a degree of success that inspired hope for further efforts along the same line. Sometimes Sluder's applications or injections of the sphenopalatine ganglion afforded much relief from pain and seemed to reduce intra-ocular hypertension. Cocainization of the ganglion appeared upon occasion to abort an attack of acute glaucoma, but its recurrence necessitated surgical intervention. The effect of Sluder's treatment was too erratic to become a dependable therapeutic agent in the treatment of glaucoma.

Studies of the autonomic nervous system by Kuntz and Christensen indicate that the benefits of anesthesia of Meckle's ganglion were not actually the result of the effect of the drug on its true ganglionic structures, but became possible because a number of sensory fibers pass through the ganglion. The effect of the drug applied to the ganglion could be duplicated if its application were spread over the area supplied by these centripetal fibers. Reflex impulses from that area were thus eliminated.

J. F. Hardesty, collaborating with Kuntz in an attempt to explain these clinical phenomena, concluded that whatever influence upon intra-ocular tension was exerted by cocainization of Meckle's ganglion was a remote sympathicotonic effect on the blood supply. Chronologically, these explanations belong to the last of our four periods in glaucoma therapy.

Schiotz, by devising a practical tonometer, made possible the notation of standardized comparable records of intra-ocular tension and thus facilitated the universal study of its variations. Popular modifications of this instrument were

provided by Gradle, McLean, and Baillart. A comprehensive discussion might include modifications of surgical instruments for ophthalmologists as well as improved equipment for the study of visual fields, scotomas, the light sense, and the capacity for light adaptation. These inventions were called forth by intensive study and in turn stimulated further studies which contributed to a better knowledge of this malady.

The last decade of the third period should be credited with the discovery of the rôle of focal infections in various ocular diseases. Toxins from such foci may be etiological factors in glaucoma. A direct specific effect on glaucoma has not been demonstrated, but repeated clinical observations of improvement in glaucomatous eyes after the elimination of dental or rhinopharyngeal infections suggest continued researches to discover the possibilities in this field. Competent ophthalmic surgeons will probably hesitate as much to inaugurate intra-ocular surgical ventures in the presence of focal infections in the mouth, nose, or throat, as they would if there were active general constitutional disease. It is not always possible to choose the time to operate for glaucoma.

Improvements in local anesthesia alone would suffice to put medical and pharmacological progress out in front in the fourth or last period of our arbitrary divisions in the story of glaucoma therapy. Akinesia and deep retrobulbar injections of anesthetics greatly facilitate the surgeon's work. The latter often reduces intra-ocular tension so that it practically eliminates the old fear of explosive hemorrhage and the sudden prolapse of intra-ocular contents. "Cone injection" (Atkinson) occasionally may permit the temporary postponement of an operation for glaucoma when conditions otherwise are not favorable to the undertaking. The problems related to glaucoma have been attacked on so many fronts in the last two decades that a limited presentation is quite inadequate. It is impossible even to enumerate all worthy efforts.

It was my privilege during the Clinical Congress of the American College of Surgeons at San Francisco last year to witness a demonstration by Otto Barkan of his special adaptation of the Zeiss binocular corneal microscope, the Vogt arc light lamp, and the contact glass of Koeppe through which a usable magnification of 25 to 40 diameters was secured in stereoscopic observations of the iridocorneal angle. Barkan, Boyle, and Maisler state last March in a publication of their investigations that they have found as "a frequent if not constant finding in so-called primary glaucoma" that "pigment dust and granules permeate the trabecula over Schlemm's canal." They continue:

> Some cling to the surface and project from it into the aqueous-like barnacles on the hull of a ship; others infiltrate the pores and pigment dust permeates to the walls of Schlemm's canal itself. The amount of pigment deposition as well as its extent relative to the total circumference is closely correlated to the stage of the glaucomatous process, its duration, and similar factors. This can well be judged by comparing the two eyes of a glaucomatous individual which present different and known stages in the development of the disease. Moreover, some pigmentary block of the trabecula and Schlemm's canal can be shown to have occurred in the second and apparently non-affected eye of such an individual with normal fields and tension of this eye from which it may be concluded that the pigmentary block is primary and the cause, rather than secondary and the result of hypertension. . . . In the compensated simple, chronic, non-inflammatory cases of glaucoma in which the entrance to the angle is potent and often wide, it appears obvious to us that the stoppage of the pores of the trabecula constitutes the immediate and sole cause of the reduced outflow of intra-ocular fluid (retention glaucoma). According to our observations to date, of some one hundred cases of glaucoma with our method, this would seem to be the first stage of many cases of decompensated chronic inflammatory glaucoma in which the iris root has become adherent to the angle wall and thus occludes Schlemm's canal.

The studies of Barkan and his associates constitute a vital contribution to the unsettled controversy about the primary lesion in glaucoma. A further observation recorded by Barkan and associates is quite significant. It concerned a 34 year old woman who, subsequent to a severe mental shock, developed "a much increased intra-ocular pressure of the right eye (tension, McLean R. E. 70, L. E. 28)." After 3 weeks of pilocarpine instillations, the intra-ocular tension "returned to normal and has remained normal without miotics ever since" (about 1 year). This case failed to show any deviation from normal in the gonioscopic examination by Barkan's special technique. Hence, they quite logically conclude that this was truly a primary "non-retention" glaucoma of a vasometer or neurogenic type, and, furthermore, that many cases of glaucoma are regarded as primary which are really secondary because the blockage by mechanical factors has not been recognized through the inadequate methods of our routine examinations.

At the meeting of the Association for Research in Ophthalmology at Kansas City last May, Barkan presented results of a few cases in which Schlemm's canal had been opened surgically by incision through these obstructions to drainage under microscopic control, with apparently good results. However, the originator of this distinct innovation in surgical methods pertaining to glaucoma was the first to insist on further time for clinical tests of the method.

Barkan's operation was based on special research. Most operations are founded on clinical or empirical observations. Impressed by the fact that a minute initial incision at the limbus with a keratome might be used as a safety valve to reduce intra-ocular hypertension before enlarging it sufficiently for a basal iridectomy, I tried out the addition of "wings" laterally and somewhat backward by scissors and secured excellent filtering scars under a large conjunctival flap without more extensive mutilation of the wound. The results of this operation on all types of glaucoma at the eye clinic of the St. Louis University School of Medicine as tabulated by M. L. Greene were quite satisfactory.

The most notable incident in the original presentation of this technique in 1922 was the fact that E. Treacher Collins, a guest of the American Ophthalmological Society on that occasion, presented in the discussion his opinion on the general principles upon which all operations for glaucoma should be based for their success.

> In acute glaucoma the operation of iridectomy opens up the normal channels for filtration of fluid from the eye; of that fact there is definite pathological proof. In long standing cases of glaucoma it is often impossible to open up the normal channels, and in such cases we can only hope for success in relief of tension by producing an artificial channel. The subject I wish especially to discuss is that of the general principles which underlie the formation of a filtration scar. First, I would remind you that what checks filtration of the aqueous humor through Descemet's membrane is the endothelium which lines it. The experiment has been made of tying a piece of Descemet's membrane over the end of a glass tube and forcing fluid down the tube; as long as the endothelium lining the membrane is intact there is no filtration into the substance of the cornea; but if the endothelium is abraded, then filtration into the cornea takes place and it becomes swollen and opaque. Since it is the endothelium which checks the filtration of fluid out of the anterior chamber, then the problem before us, in the formation of a filtration scar, is how to create a permanent gap in the endothelium lining the anterior chamber.
>
> Another important point is that the wounds of the iris made with aseptic precautions and kept bathed with aqueous humor never form granulation tissue; the cut surface remains always open. The same applies to the cornea and corneoscleral tissue; an aseptic wound at the sclerocorneal margin kept bathed with aqueous will not heal and will not form granular tissue. So we can make a permanent subconjunctival opening in the sclerocorneal tissue at the angle of the anterior chamber.
>
> Another physiological fact to remember is that after any incision of the cornea the endothelium will try to spread across the gap, and the best way to prevent it from doing so and so insure a permanent opening is to take away a large piece of Descemet's membrane. If you take away a large circular piece of Descemet's membrane or make the division in it gape widely, there is little chance of the endothelium crossing over the opening. In doing a trephining operation it is most important to remove a circular piece of this membrane from the posterior surface of the cornea. Descemet's membrane is not very adherent to the corneal tissue, and in doing a trephine operation we are liable to have it peel off the circular disc which we remove and be left behind *in situ;* a filtration scar would not then be produced.
>
> Another important point in performing a trephining operation is to avoid any infection of the wound. If we get an infection, even with mild organisms, the lips of the wound become inflamed and the gap is closed with granular tissue.
>
> One cause of failure in trephining is leaving Descemet's membrane behind. A second cause of failure is sepsis, leading to the formation of granulation tissue; a third cause is a downgrowth from the epithelium at the surface between the lips of the wound. That is most liable to occur if we do not get a good conjunctival flap or if we make a buttonhole in it. The epithelium tends to grow in over any raw surface left by a wound; it may go a considerable distance in between the lips of a wound, and may even extend into the anterior surface.
>
> So there are three things it is well to remember in performing a trephine operation: the removal of Descemet's membrane, the prevention of sepsis, and the danger of a downgrowth of epithelium along the tract of the wound.

Among subsequent modifications of recognized operative techniques were the addition of lateral wings to the round trephine opening of Elliot and a proposal to do the cyclodialysis backward from the angle of the anterior chamber, but the emphasis on research overshadowed all else during these recent years. Unfortunately, animal experiments cannot precisely duplicate the conditions encountered in the glaucomatous eye.

About 10 years ago Magitot set himself the task of trying to clarify the conflicting theories concerning glaucoma. He proposed to gather evidence and treat the case just as one would a criminal investigation. After a very comprehensive review, he arrived at the following conclusions:

> All the theories which have been enunciated for the explanation of glaucoma, the circulatory concept, nervous theories, retention theories, etc., fail to withstand analysis. . . . Even the physicochemical conception, so seductive because of its modernism, constitutes an explanation of the symptom hypertension, but not of the disease, for the acidobasic disturbance which it postulates is never primary. It is but secondary to the condition of the blood vessels. When one actually traces the phenomena to their source, he finds himself at length in the presence of but a single element, the pathogenic key to the affection, the state of the capillary permeability.

Magitot considers "beyond a doubt that the results obtained by the use of the two current substances—pilocarpin and eserin—are the consequence, not of their accessory action on the sphincter or the ciliary muscle, but *of their attack upon* the capillary endothelium." He attaches the utmost importance to the experiment in which "sodium iodide introduced into the circulation passes rapidly into the aqueous humor. However, if one instills beforehand either pilocarpin or eserin, the transfusion of the drug does

not occur. Should the instillations be preceded by one containing cocain, the dialysis of the substance into the anterior chamber will then proceed in the usual manner."

The fallacy of drawing general conclusions from the diffusibility of one substance alone is apparent in this instance. The recent experiments of James and Siefker show that "eserin increases the rate of diffusion of glucose into the aqueous of the eye while atropine retards it."

We may concede the significance of simple edema or angioneurotic edema of intra-ocular tissues in glaucoma according to the tenets of Magitot. His emphasis on the variability of capillary permeability was confirmed in this country by the experiments of Petersen and Goldenburg. However, it seems hardly necessary to regard as a secondary effect the unmistakable action of miotics on the ciliary musculature and iris in opening the iridocorneal angle for better drainage into the Schlemm's canal and in making possible increased absorption directly into the veins of the iris.

Another effect which must accompany the ciliary spasm caused by miotics has been passed unnoticed. It was shown by classical experiments of Hensen and Voelckers (1867) that contraction of the ciliary musculature causes an advance (forward and inward) of the vitreous humor, but the possible effect of this movement on fluid currents in the anterior chamber was ignored until Machemer and von Pflugk observed the movements of a tiny thread of persistent pupillary membrane forming a cord across an arc of the pupillary border. They recorded these movements photographically on a movie film. They demonstrated a current forward into the anterior chamber through the pupil when an active ciliary contraction takes place under an impulse of ocular accommodation. Such a propulsion of fluid into the anterior chamber may act like the fluid sent into a blocked drain pipe by the plumber's force pump. Though this may be a minor effect, its tendency will be to improve drainage from the eyeball through the normal passages into Schlemm's canal. Indeed, Groenholm reported that active accommodation reduced intra-ocular tension in glaucoma.

Preponderance of hypermetropic eyes among the glaucomatous has brought forth references to the size and relations of the iridocorneal angle to the lens and other parts of the eye. To these may be added the fact that in hypermetropic eyes Mueller's annular or ring muscle is relatively hypertrophic. In its contraction this muscle presses backward against the vitreous humor instead of drawing the latter forward as does the longitudinal (or Bruecke's) portion of the ciliary musculature which is dominant in myopic eyes.

Vascular obliterations, hyaline degeneration, and sclerotic lesions have been found too often in non-glaucomatous eyes to be truly pathognomonic of glaucoma.

The lack of perfect parallelism between the degree of intra-ocular hypertension and evacuation of the disc; atrophy of the optic nerve, notches, or scotomas in the visual field; variations in the light sense; mydriasis; or corneal edema does not refute the statement of Morax that "the term glaucoma has come to be synonymous with ocular hypertension, a symptom the expression of which may be extremely varied, yet which for the clinician and the therapist is the one to be combated."

The latest and most authoritative information about capillary permeability was supplied by the researches of E. M. Landis of the University of Pennsylvania who, by an ingenious original device, secured the first dependable measurements of capillary pressure. Landis' studies suggest the probability that some initial retention may be a cause for prolonged edema in the intra-ocular capillary meshes. Landis found by calculations and direct observation that:

> Arteriolar capillary pressure is higher than venous capillary pressure by a significant amount. . . . In man the arterial capillary pressure amounts on the average to 45 centimeters of water, venous capillary pressure to about 22 centimeters of water. . . . The gradient of capillary pressure in at least four species is such that on the average, arteriolar capillary pressure is above the osmotic pressure of the plasma colloids while the average venous capillary pressure is below the osmotic pressure of the plasma colloids. It is physically possible, therefore, that on the average, fluid is filtered from blood during its passage through the arteriolar portion of the capillary network while absorption takes place in the venous portion of the capillary network. Though movement in individual capillaries will diverge from the average in accordance with variations in capillary pressure diameter and flow.

Significant in its import for the explanation of certain phenomena of intra-ocular hypertension is Landis' finding that the capillary pressure in the arterial or venous portions of the network may be separately influenced by various agents. Arteriolar constriction increases peripheral resistance and then capillary pressure becomes lower. Thus, while general blood pressure becomes higher, capillary pressure may be lowered. Landis observed such effects after constriction produced by adrenalin. Other conditions being the same, a drop in arteriolar capillary pressure means reduced filtration of fluids into tissue spaces.

These reactions noted by Landis explain the

excellent results obtained by Hardesty in the constitutional treatment of glaucoma by adrenalin and ephedrin. Landis found that adrenalin or cocain by arteriolar constriction diminishes conjunctival edema. Similarly, they might thus diminish edema in the uveal tract and lower intra-ocular tension, but since the immediate constriction of arterioles is followed by dilatation of the pupil with tissue compression of the veins of the iris and a possible obstruction of the iridocorneal angle, there may be a delayed absorption of intra-ocular fluids that more than counterbalances the inhibition of capillary filtration, thus creating hypertension within the eyeball.

Thus is offered a possible explanation for the contradictory effects of adrenalin, first proposed for glaucoma therapy by Wessely, and especially manifested by Hamburger's glaucosan and noted in John Green's report on suprarenin bitartrate. It suggests the use of a controlling miotic—eserin, or stronger solutions of pilocarpin—to neutralize the mydriatic effect of epinephrin on the iris. Clinically, the instillation of epinephrin followed forthwith by eserin has yielded very satisfactory therapeutic results in glaucoma.

On the other hand, Landis points out that "dilatation of arterioles shifts the peripheral fall of blood pressure toward the capillary network, *elevates* capillary pressure. . . . In man cutaneous capillary pressure rises during hyperemia produced by heat, histamin, and acute inflammation." Arteriolar dilatation and active hyperemia which increase the rate of capillary blood flow and elevate capillary pressure, facilitate filtration of fluid into the tissues, as might be expected.

Duke-Elder's suggestions about the relation of histamin to glaucoma are brought to mind by these notations of Landis. Also, it would appear that a low grade inflammation in the uveal tract might produce the dust-like pigment "barnacles" observed by Otto Barkan as obstructions to Schlemm's canal. Such an inflammation might be caused by toxins from unnoticed foci of infection in the mouth, nose, pharynx, or elsewhere, and the inflammation of ocular tissues might be so mild as to escape observation. Then the insidious onset of symptoms of glaucoma might appear as the primary indication of a departure from normal conditions within the eye. This train of events has been duplicated repeatedly in my clinical experience.

Thiel found that miotics produced vasodilatation in the iris of albinic animals; Koller reported similar effects. Therefore, it is interesting to note that Wessely was able to prove by animal experiments that the first effect of miotics is a slight rise in intra-ocular pressure which is entirely consistent with Landis' observations of increased capillary filtration after vasodilatation.

For the glaucomatous eye, Landis' observations on the venous portion of the capillary network have equal significance. Because, under average conditions, capillary pressure is definitely lower in the venous portion of the capillary network, that is, below the colloid osmotic pressure of the blood, absorption of fluids from tissue is favored. However, Landis finds:

> A rise of venous pressure elevates capillary pressure even when the obstruction involves only a few veins or venules. . . . It is impossible for capillary pressure to be below venous pressure except for very brief periods. . . . Loss of fluid from the blood by filtration is detected consistently—when capillary pressure is elevated by raising venous pressure. Likewise, capillary pressure is high in dependent parts of the body owing primarily to the hydrostatic pressure of the blood in vertically placed veins.

The obstruction of Schlemm's canal, a venous pathway, as observed by Otto Barkan, may thus become the direct cause of intra-ocular edema in simple chronic "retention" glaucoma without inflammation. The same explanation may be applied to the effect of lesions of the vorticose veins.

Landis' notations about the effect of posture and tissue pressure on venous pressure and thus upon capillary pressure and permeability facilitates understanding of the diurnal variations in intra-ocular pressure which, in a person having glaucoma in one eye, may be observed in both eyes simultaneously, though more marked in the affected eye (Thiel-Magitot).

It has been assumed that the sensory nervous system might by its trophic action on the endothelial cells alter the capillary permeability and thus produce an acute crisis of edema, but Landis endorses the opinion of Krogh (1929) who stated:

> When I review all the facts that have come to my notice, I have no hesitation in saying that there is no trustworthy evidence of the capillaries having any power of hindering or favoring the passage by diffusion of all kinds of crystalloids through the endothelium.

Landis reported that when injury produces local or general edema, it is due "fundamentally to increased capillary permeability with easy passage of proteins and water through the endothelium." However, he adds:

> Agents which reduce systemic blood pressure or local capillary pressure prevent edema fluid from collecting even though the capillary wall is severely damaged. . . . Conclusions concerning capillary permeability are often made without considering in detail the many simple physical forces concerned in the movement of water and of dissolved substances through the capillary wall. Of these

forces, capillary blood pressure is neglected more frequently than any other. This has resulted in the postulation of theories involving either active intervention of the endothelium or various modifications of its permeability under conditions inadequately controlled from the physical standpoint.

A therapeutic suggestion to control the secondary glaucoma following contusion of the eyeball is contained in Landis' suggestion that lowering of the systemic blood pressure or local capillary pressure may prevent edema. Clinically, it has seemed that conjunctival instillations of epinephrin combined with miotics or local anesthetics are better than surgical drainage in hyphemia and similar conditions. In prolonged posttraumatic hypertension, the search for foci of infection and their prompt elimination is indicated.

Landis' research tends to fill in the blank spaces of the puzzle picture presented by glaucoma. It emphasizes the mechanical phase and discourages vague speculation. Considering these conclusions drawn from direct measurements and observations on the general circulation in relation to intra-ocular structures, it becomes apparent that an active hyperemia may begin the vicious circle which leads to hypertension by increased filtration into the tissues of the uveal tract, while any retention which may obstruct one or more veins may increase the capillary pressure to a degree to prevent absorption and thus upset a delicately balanced inflow and outflow of intra-ocular fluids.

Variations in the colloid osmotic pressure of the blood is another factor in capillary permeability given careful consideration in Landis' researches. He states that apparently colloid osmotic pressure of the blood retains fluid within the vascular system and acts quantitatively in opposition to capillary pressure. By experiments on dogs, Leiter showed that chronic hypoproteinemia leads to the accumulation of extravascular fluid with outspoken edema when the plasma protein falls to 3 per cent or less. Leiter and other investigators found that "even in the presence of a low plasma protein, however, edema cannot develop without an adequate supply of salt and water." Landis calls attention to the fact that clinical experience in the treatment of edema has shown empirically that a physical tendency toward edema can be neutralized by restricting the intake of salt and water or by increasing the excretion of water and salt by means of diuretics. The suggestion of a restricted salt intake has been applied rather helpfully in the general care of chronic glaucoma.

The frequent occurrence of glaucoma in epidemic dropsy, a disease not uncommon in Bengal, has compelled ophthalmologists the world over to ponder the possible relation between remote toxic modifications of the colloid osmotic pressure of the blood and glaucoma. The first description was given by Maynard who reported 100 cases occurring from 1908 to 1909. Subsequently, Murkeji reported observations on 253 cases in 1927. Kirwan, to whom ophthalmology will remain indebted for a thorough comprehensive study of the disease, reported on 325 patients who came under his care in outbreaks during 1929–1930 and 1932–1933 in Bengal and Calcutta. Kirwan closed his first report with the statement:

> This subject presents a large field for experimental work, and if carried out, one can look forward to the day when a great part of the problem of glaucoma will be solved by therapeutic measures or methods of prevention.

Soon, opportunity knocked on the door of one who was prepared. In June of this year Kirwan reported another outbreak of this interesting disease in 1934–1935, during which period 1,695 cases of primary glaucoma in association with epidemic dropsy came to the eye infirmary, Medical College Hospital, Calcutta, under his direction.

Kirwan names as primary factors in the production of an increased amount of aqueous humor the following:

1. Decrease in the colloid osmotic pressure of the serum.
2. Increase in the permeability of the capillary wall so that the albumen molecules can pass through from the capillaries into the aqueous humor. The albumen molecules are much smaller than those of other proteins in the blood and can pass out more easily than others into the aqueous. The change in surface tension is closely associated with the change in permeability. It is probable that the histamin-like body which has been proved to be present in some cases associated with epidemic dropsy produces similar reactions.
3. Increase in hydrostatic pressure in capillaries.

He adds what, from consideration of Landis' researches, might have been anticipated.

> It is obvious that the operation of these three factors serves to aid the transudation from the capillaries into the aqueous humour in the eyeball and to hinder reabsorption from the latter thereby causing an increased amount of aqueous humour.

He continues with the clinical description of this condition when primary:

> Glaucoma associated with epidemic dropsy is characterized by very high tension occurring in both eyes at the same time, no lowering of the tension by miotics, the presence of a normal or deep anterior chamber, the absence of any inflammations or external signs of congestion, the occurrence of glaucoma in persons irrespective of age, and glaucoma may be the first manifestation of the toxemia.

The toxemia is apparently caused by "the ingestion of diseased, stored, parboiled rice as patients recover quickly after stoppage of rice in early cases; more advanced and late cases take a much longer period to recover according to the duration of the disease."

He continues:

> Relapses invariably occur if the rice is resumed too early. These are liable to occur even when healthy rice is eaten, suggesting that infection of the rice occurs in the intestines of the patient.
>
> In the eye, microscopic examination of the filtration angle shows that the canal of Schlemm and the tissues in the immediate vicinity do not show any abnormalities either in cellularity or increased fibrosis. The epithelium of the ciliary processes also does not show any change. Increased dilatation of the blood tissues is seen in the subepithelial connective tissue of these processes. There is also an enormous dilation of the choroid, but there is no evidence of any inflammatory process to be found in the whole of the uveal tract.

One is obliged to look upon this remarkable ocular disease as a coincident manifestation of the general toxemia plus the changes in the aqueous humor that closely resemble what has been postulated for the etiology of glaucoma by Duke-Elder.

In his first report Kirwan stated:

> The dietetic and medicinal treatments for this type of glaucoma are most unsatisfactory. . . . Miotics, such as pilocarpine and physostigmine, are practically useless and these have been used so extensively that the pupil becomes pinhole in size. This therapeutic sign is useful in the differential diagnosis from ordinary chronic primary glaucoma in which tension reacts more or less to miotics. Epinephrin packs placed under the upper lids have also proved useless.

Physostigmine was not prescribed as it caused hyperemia of the conjunctiva and made operative treatment more difficult. Kirwan reported that by far the most successful method is the Elliot operation with a 1.5 millimeter trephine. Anterior sclerotomies were followed by tension "as high or even higher 12 hours after operation. . . . A complete iridectomy was also tried in a number of cases and was found to be of little use in keeping the tension down." He concludes: "the operative treatment is symptomatic and is intended to prevent permanent damage being done to the retina by the increased intra-ocular tension till the general disease has been cured by the elimination of the offending toxins."

### CONCLUSIONS

Surgical success is apt to be brilliant, stunning, as was von Graefe's first operation for glaucoma. The achievements of medical research and therapy rest on long continued, painstaking attention to detail. Happily, surgery and medicine are not competitive as represented for provocative discussion. All ophthalmic surgeons resort to medication before surgical intervention. Not so many resume medical therapy after operation. In the hospitals and dispensaries of St. Louis University School of Medicine we have noted definite improvement in central vision and in the size of the visual fields as the apparent result of postoperative local and systemic medication in addition to what had been gained by the operation.

Magitot's assertion that astonishing results may be obtained by medical care in chronic primary glaucoma—results that are superior to those of mere surgical routine—has been verified in our experience, but it is equally true that in quite a number of patients the most impressive gains have been made after surgical operation has seemingly prepared the glaucomatous eye for a better response to medical therapy. Hence, exception may be noted to his conclusion that "a surgical operation is not indicated except in the acute cases."

It adds to the cares and responsibilities of the ophthalmologist to keep such cases under observation after, as well as before, surgical operation. Full approval is gratefully given by ophthalmologists to the National Society for Prevention of Blindness which sponsors training courses in ophthalmic social service intended to lighten this burden by promoting better co-operation between physician and patient. There is no better way, for it is more emphatically true today than when LaGrange said it, that glaucoma signifies a diseased eye in a diseased body.

## Discussion

DR. THOMAS A. O'BRIEN, Philadelphia: It is evident from Dr. Luedde's splendid monograph that much has already been accomplished in attacking the problem of glaucoma. However, despite the remarkable work of Donders, of Landis, and of numerous other careful investigators, no real cause has yet been offered for glaucoma; and we are at present still held in the grasp of a dilemma, being forced to choose either horn, medicine, or surgery.

From the clinical side, therefore, let us review some of the chief causes of this disease. Among the chief factors are age, it being most frequent in the fifth, sixth, and seventh decades. In this age group we are forced to consider the presence of arterio-

sclerosis with its wide effects on the human organism. Sex shows a slight predisposition toward females. The effect of heredity has been pointed out and bears somewhat upon the disease. It is transmitted by both sexes and exhibits the factor of anticipation. Hyperopia is often seen in primary glaucoma and its presence cannot be overlooked. The result of a constant dilatation of the pupil is evident when one considers that it effectively blocks drainage and tends to increase intra-ocular tension. Nerve shock, strain, and severe febrile attacks are factors which are thought to be contributing agents acting probably through the sympathetic vasomotor system. A proper search for focal infections should be routine procedure. The rôle of an infected prostate, a chronic cholecystitis, and other prominent foci should be adequately investigated.

The medicinal treatment of glaucoma aims chiefly at the prevention of hypertension with its ultimate ocular destruction. Treatment is primarily dependent upon the use of miotics, second upon massage, and third, upon heat and electricity. And herein let me sound a distinct warning, that any progressive loss in vision points to the immediate consideration of surgical intervention.

The surgical means at our disposal, while somewhat more elaborate and optimistic than previous methods, must not be regarded as entirely satisfactory. The original iridectomy of von Graefe is still the sheet anchor of the surgeon. Iridectomy holds forth good hope in many cases of chronic glaucoma. In the performance of surgery, the type and technical difficulties of the various operations should be used in proportion to the skill of the operator. Elliot's trephine is most advantageous in certain cases. The constant observance of rigid pre-operative and postoperative care will prevent the occurrence of many a postoperative calamity. The ability of the patient to stand the rigors of surgical procedure, the routine requirement of a base line medical examination and the proper judgment as to the type of operation employed, all mark the hand of a clear thinking surgeon.

The prevention and treatment of juvenile glaucoma is another important element in the study of this disease. In juvenile glaucoma Elliot's operation has proved most successful. In the treatment of primary glaucoma we must avail ourselves of the best known methods, while in combating secondary glaucoma we must first attack the primary cause rather than the glaucomatous eye.

In conclusion, we might be apt to view the situation with somewhat of a pessimistic outlook. Yet when we observe the intense activity of the research worker and the eager co-operation of the medical and surgical professions, we are forced to recognize the fact that the union of these efforts will no doubt eventually conquer this terrific malady.

# EDITORIALS

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FEBRUARY 15, 1937

## THE 1936 CLINICAL CONGRESS

THE twenty-sixth annual session of the Clinical Congress of the American College of Surgeons is now a matter of history and it was indeed a pleasure to the Philadelphia members to have been hosts to the visiting Fellows.

The registration was one of the largest in the history of the College, and were one to judge by the attendance at the various clinics and demonstrations, and the interest in them shown by the Fellows, it would be no exaggeration to say that the meeting was a success from every aspect.

With 44 hospitals participating, it was possible for one to witness the various methods of treatment covering almost all branches of surgery and its allied specialties, of which latter group, those devoted to ophthalmology and otolaryngology were especially well represented.

The various symposia were carefully planned and topics of timely interest were presented. Among the most interesting and best attended of these might be mentioned the two devoted to fractures—one held under the auspices of the Regional Fracture Committee of the College and the other held the following day as part of the regular program. In each of these instances a capacity attendance was on hand, and from the interest shown it is safe to say that many of those present regretted that time did not allow a discussion of the presentations.

The symposium on cancer was excellent and served to stress the progress that has been made in the earlier recognition and treatment of the various aspects of this condition.

As in former meetings, the Hospital Standardization Conferences afforded an opportunity for the expression of opinion upon many aspects of this problem, so intimately associated with the practice of medicine and surgery, and it was encouraging to note the advances which have been made in recent years in the approach to a solution of this problem of many angles.

At the meeting of the State and Provincial Executive Committee plans were made to extend and improve the sectional meetings for the coming year, and most encouraging reports were submitted of those held since the last meeting of this committee. It was the opinion of many present that these sectional meetings are productive of worth while results as a means of educating physicians and through them, the laity, and that they serve as a means of dissemination of the most recent advances in the subjects presented.

In conformity with a custom adopted in recent years, an evening Community Health

meeting was held in the Municipal Auditorium, and although the attendance was not as large as upon previous similar occasions, due to lack of publicity by the daily press, the audience made up in enthusiasm what it may have lacked in numbers.

All of the evening sessions at the Irvine Auditorium were well attended; the topics were of practical and general interest; the address of the retiring President, Dr. Donald C. Balfour, was presented; and the Annual Oration in Surgery was ably delivered by Sir James Walton. At two evening sessions at the Bellevue-Stratford Hotel addresses on ophthalmology and otolaryngology were presented.

The Convocation on the last day followed the accepted course of preceding similar occasions with the presentation of Candidates and the conferring of Fellowships and Honorary Fellowships, followed by the President's Inaugural Address by Dr. Eugene H. Pool and the Fellowship Address by the Hon. Harold M. Stephens, Associate Justice of the United States Court of Appeals of the District of Columbia.

The exhibits at the Bellevue-Stratford were a source of continued interest, the outstanding one possibly being the motion pictures showing various operations. It is hard to see how these colored films can be further improved and many of those who saw them were in accord that the surgical technique depicted was much clearer than could be obtained from a crowded amphitheater.

This report would be incomplete were one to omit mentioning the splendid work done by the members of the Women's Auxiliary to the Philadelphia County Medical Society who, under the able leadership of their chairman, Mrs. John Allan Bertolet, did so much to entertain the wives and other members of the families of the visiting physicians. This consisted chiefly of luncheons, teas, and visits to interesting and historic places in and about Philadelphia, and we feel certain that the activities of this society added greatly to the pleasure of our guests.

HENRY P. BROWN, JR.

## HOSPITAL STANDARDIZATION

THE nineteenth annual Hospital Standardization Conference of the American College of Surgeons was held in Philadelphia during the Clinical Congress, October 19 to 23, 1936. The four day hospital program was based on Hospital Standardization, and touched practically every phase of hospital administration. The interest in the program was attested by the fact that none of the session halls after the first day could accommodate those who came to the meeting. Among the many noteworthy features of the program, two in particular should be mentioned: The symposium on maternal care in the general hospital, which was followed by an entire session at the Pennsylvania Hospital devoted to demonstrations of technique and procedures; and the symposium on medical records, which was followed by an afternoon session in St. Joseph's Hospital on the dramatization of medical records.

Twenty years ago the first organized survey of hospitals of the United States and Canada was undertaken by the American College of Surgeons, introducing what has now become universally known as "Hospital Standardization." During this period, through more than 40,000 individual surveys, there has been amassed a most comprehensive and valuable collection of factual data regarding hospitals. On October 1, 1936, 2,577 hospitals were placed on the Approved List, as compared with 89 approved hospitals placed on the list which was compiled following the first survey in 1918. Progress has not been spectacular

or phenomenal, but it has been steady and substantial, and the hospitals have co-operated voluntarily and without legal compulsion. Despite the most trying economic conditions in the history of hospitals which prevailed during the past 6 years, there was no lowering of standards. On the other hand, in the same period a growing consciousness of Hospital Standardization has been manifested by managements of hospitals and members of medical staffs who have endeavored to fulfill the requirements necessary for approval—requirements which are fundamental in insuring proper care to the hospitalized patient.

An ethical, high grade medical staff comprised of graduates of approved medical schools is one of the great assets of a hospital. The granting of privileges, in a lesser or greater degree, to irregular practitioners of medicine is inconsistent with the principles of Hospital Standardization, and the College will not knowingly keep on the Approved List an institution which countenances such practices. There must be full compliance with the principles which are set forth in Clause II of the Minimum Standard for Hospitals, which reads as follows:

"That membership upon the medical staff be restricted to physicians and surgeons who are (a) graduates of medicine of acceptable medical schools, with the degree of doctor of medicine, in good standing, and legally licensed to practice in their respective states or provinces; (b) competent in their respective fields; and (c) worthy in character and in matters of professional ethics; that in this latter connection the practice of the division of fees, under any guise whatsoever, be prohibited."

These requirements apply equally to internes and residents. They, too, must be graduates of approved medical schools.

A subject of vital importance to every hospital is the proper control of professional activities. This is a responsibility of the active medical staff, a fact which, unfortunately, medical staffs do not always recognize. There have been encouraging indications in the past year that members of medical staffs are realizing more and more that acceptance of membership on the medical staff brings with it not only definite privileges but also definite responsibilities.

Proper medical staff organization is fundamental in the control of the professional activities of any hospital. This presupposes a division or grouping of the staff into clinical departments or services and the appointment of heads or chiefs of the services. So far as practicable and possible, the chiefs or heads of departments should be selected from among specialists who are recognized in their respective fields, such as Fellows of the American College of Physicians, Fellows of the American College of Surgeons, or members of other national organizations or qualifying boards which embrace the specialties of medicine and surgery. This policy will assure better leadership and greater efficiency. Indeed, the scientific standard of any hospital can be judged by the constitution of the medical staff, its organization, and the manner in which it functions. Too often definite leadership is lacking. Frequently members of the courtesy medical staff are not restricted in their use of pay wards for their patients, and unnecessary and incompetent surgery results. There is no more effective method of controlling surgery than to have the surgical staff of the hospital, through a qualifications committee, determine who shall or who shall not be permitted to do major surgery in the hospital, using training and experience as the basis for the decision. This applies also to the other clinical services of the hospital. If control of the professional activities of the medical staff is conscientiously exercised, the

result will be a high quality of professional work and increasing efficiency in the hospital.

Medical records or case studies of high quality are essential to the accurate and scientific practice of medicine, for they are the production sheets of the hospital. This applies to all types of patients—free, part pay, or pay. There is an erroneous feeling that the private patient does not require or should not have a complete medical record. There should be no differentiation, as the complete record redounds to the benefit of the patient. The record of a private patient should be as complete as the record of the ward patient.

It is the definite responsibility of the management and the medical staff of every hospital also to see that an accurate and complete case study is made of each patient, and that this is evidenced through a promptly and properly written medical record which contains sufficient data to justify the diagnosis and to warrant the treatment, and a record on which the follow up and end-results are finally recorded. It is important that the medical records should be used after they are written. Too frequently they are filed away and merely allowed to accumulate dust; and thus the record room becomes a "cemetery for medical records." Records should be put to the many definite beneficial uses which they can and should serve. Periodic group studies of diseases should be encouraged. There are many diseases upon which such studies can be made through a review of medical records. In the successful compilation of data for this purpose, the medical staff must formulate a plan or outline for each specific study, so that the essential data may be obtained. Such studies will reveal not only the efficiency or deficiency of the medical records system, but will result in a better evaluation of the professional work of the medical staff and of the efficiency of the hospital as a whole.

The information which the practitioner of medicine accumulates through personal examination of his patient must be supplemented by numerous adjunct facilities or departments, such as the clinical laboratory, x-ray department, electrocardiogram, metabolimeter, and other physical agencies which result in a more comprehensive study of disease. All of these facilities must be used judiciously and they must not displace the physician's own method of physical diagnosis. They should be used to elucidate or confirm the findings which were recorded after a careful physical examination and should serve as a basis for supplementary treatment. It is imperative that there should be competent medical supervision over every adjunct diagnostic and therapeutic facility which is utilized. Frequently difficulty is encountered in securing this supervision, as the number of qualified clinical pathologists, radiologists, cardiologists, and other such specialists is inadequate to supply the demand of every hospital which has these essential services. Therefore, whenever possible and practicable, the services of specialists in these respective fields should be shared by several hospitals. The survey of the hospital field in the United States and Canada reveals that every hospital of 25 beds and over can work out a plan to maintain its own complete service, either within the institution or by an acceptable affiliation with another institution.

The successful and progressive practitioner of medicine—be he a physician, a surgeon, or a general practitioner—must affiliate himself with a hospital in which he has at his ready command the necessary facilities, equipment, and trained personnel to assist him in rendering the best possible service to his patient, both in diagnosis and treatment. Such an environment is assured to him in an Approved Hospital. MALCOLM T. MACEACHERN.

# PRESIDENTIAL MEETING, CONVOCATION

## THE FUNCTION OF THE AMERICAN COLLEGE OF SURGEONS

DONALD C. BALFOUR, M.D., F.A.C.S., Rochester, Minnesota

THE annual meeting of the American College of Surgeons is not only an event of national import to medicine, but also it serves to visualize to the Fellows of the College and to the medical profession the status of surgery and its allied fields. The officers of the College have, by reason of long experience and careful planning, arranged a program which can be said to be a most comprehensive and co-ordinated presentation of the field of surgery. Since the activities of the College have been characterized by their inclusiveness, the arrangement of a program to represent these activities has not been an easy task, and those who have had this responsibility are to be congratulated. The presentations in the scientific sessions are by men of authority in their various fields, and the conferences, particularly those pertaining to hospital standardization, cancer, fractures, and industrial surgery, will be, as they have been in the past, characterized by definite contributions to the advancement in these fields. Distinguished visitors from abroad have honored the College by their presence and by participation in its program. To them I wish to convey on behalf of the College a most hearty welcome and to extend our greetings through them to the members of their profession at home.

On such an occasion as this, therefore, it should be appropriate to present briefly the work of the American College of Surgeons, to discuss some of the problems which are of common interest to all engaged in the practice of medicine, and to outline the plans by which the aims and ideals of the College can best be fulfilled.

The function of a College of Surgeons, as interpreted by those colleges which have been established in English speaking countries, has been the conferring of degrees in surgery. The various colleges differ markedly in the requirements which have been set up for the attainment of these higher degrees. In Great Britain and Ireland with a combined population of 50,000,000 there are three colleges which have been in existence for one century or more, viz., the Royal College of Surgeons of England, the Royal College of Surgeons of Edinburgh, and the Royal College of Surgeons of Ireland. In Australia and New Zealand the Royal College of Surgeons of Australasia was established in 1926 for a population of 8,000,000, and the Royal College of Physicians and Surgeons of Canada was established in 1929 for a population of 10,000,000. In any comparison of the aims, problems, and accomplishments of these colleges with those of the American College of Surgeons, it should be remembered that the American College of Surgeons has carried on its activities for a population of 130,000,000 during a period in which an enormous impetus has been given to surgery by the remarkable results effected in established, as well as in new, fields and the consequent great and rapid increase in the number of practicing surgeons. In the formation of the American College of Surgeons, the requirements for fellowship in the College were, therefore, placed on a different basis than those of other colleges of surgery in the belief that an organization of surgeons who were, in the opinion of those qualified to know, rendering satisfactory surgical service for their communities, large and small, would be the most effective type by which the primary purpose of the College, that is, raising the general level of surgery, could be achieved. Professor E. W. Archibald, in commenting on the educational work of the College, has referred to it as "finer, more extensive, and more effective than that carried on by any other surgical society of which I know." The influence, therefore, of the College in this phase of medical education has been and should continue to be of paramount importance.

In the general field of education, no profession has been confronted with greater problems than has the medical profession. The great progress which has been made in the past 30 years has come through the work of the Council on Medical Education and Hospitals of the American Medical Association, for the dissemination of its findings

Address of the Retiring President, presented before the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

to the profession and the public has accomplished, without legislation, far-reaching results. The reduction in the number of medical schools in the United States from 160 in 1905 to 66 four-year schools today, the raising of entrance requirements, the more effective balancing between adequate instruction in fundamental sciences, didactic teaching and bedside teaching, and the encouraging of the requirement of a year in hospital before the doctorate is conferred, have elevated immeasurably general medical practice. With the elimination of inadequate medical schools, has arisen the problem of the selection of applicants for entrance to medical schools. The number of applicants in the United States in 1934 and 1935 was approximately 13,000, of which only 6,300 were enrolled. It is generally agreed that even this number is in excess of the present needs of this country, since the ratio of physicians to population is higher than in any other country: United States, 1 to 700; Great Britain, 1 to 1,400; Germany, 1 to 1,500; and Scandinavia, 1 to 2,150. Furthermore, the distribution of physicians in the United States apparently is more unequal than in other countries because the high requirements of a medical education today discourage the physician who has successfully met these requirements from practicing in a community in which he does not have access to those facilities which he has been taught are requisite to modern medical practice. As a result, in the smaller communities the number of physicians in relation to the population is decreasing rapidly, whereas in the larger centers it is increasing.

The solution of this problem then would seem to be, as President Sproul of the University of California has pointed out, that "few things more helpful to professional education could be done than to determine the approximate needs of the state respecting each profession, disseminate this information widely, and thereby, so far as possible, obtain a voluntary limitation of the numbers of candidates for professional work and a voluntary sorting of such candidates among the various professions."

The purposes of the American College of Surgeons could be best fulfilled, as I have pointed out, by gaining the interest and support of those surgeons throughout the country who are able to meet the requirements for fellowship. These men, since they are in active surgical practice and carry on their work largely in hospitals and are familiar with the problems of surgical practice as they actually exist, are, therefore, in a better position to aid in solving these problems than any other group of men. It is interesting to note that on this basis of admission to fellowship, there are now approximately 11,000 Fellows of the College in the United States and Canada. Of this number approximately 5,500 are listed as general surgeons, a ratio of 1 general surgeon to 22,000 population.

When it is considered that the aim of the American College of Surgeons has been to provide an increasingly better surgical service, it is significant that the quality of surgery during the last 20 years has been improved amazingly, and instances of unnecessary operations, as well as evidences of what might be charged as poor surgery, have greatly decreased. Much of this can be attributed directly to the educational program of the American College of Surgeons, for those who aspire to fellowship are aware that they must convince the leading surgeons in their states, who may be members of the Credentials Committee, that they are rendering a surgical service to their communities worthy of recognition by the College. The primary responsibility for fellowship in the College rests with these committees, and the difficulties of fulfilling this responsibility are well recognized by the Board of Regents. In the state of New York, the plan of establishing an advisory Credentials Committee subsidiary to a large Credentials Committee has been tried and has proved to be so successful that it probably will be instituted in other states.

Sound as have been the requirements for admission to fellowship in the College, the Board of Regents has been conscious that since medical education is based on more and more exacting requirements, the College should make every effort to meet such standards, yet there is also the danger of hastily establishing standards which would defeat the whole purpose of raising the general level of surgical practice. The Board of Regents has also decided that for fellowship in the College after 1938, 2 years of intensive training in surgery following an adequate interneship will be included in the present requirements of a minimum of 7 years' interval following graduation. This would presuppose that the next desirable requirement would be the possession of a higher degree in surgery conferred by approved graduate schools, but the lack of opportunity for acquiring such a degree in this country would make such a step impractical at present. As President Sproul has said in commenting on this danger in general education: "Until we have more dependable methods of judging applicants, it will continue to be dangerous, even though necessary, to make choices, to select and reject. A safety valve, although hardly an argument in favor of limitation, is the fact that excluding students from the better

schools does not prevent them from entering the profession. They merely go to an institution which is less particular, with the result that the same number become doctors but more of them are less well trained. Every form of prohibition seems to produce such complementary form of 'bootlegging.' Even the rigid limitation of the right to practice does not ensure beneficial results except perhaps on the economic level."

The College, therefore, has wisely reserved the right to admit to fellowship those who have not had superior opportunities, but who have, by natural aptitude, continuous study and observation, acquired surgical competency. It is important in this respect to record a study by Dr. Bowman C. Crowell of the training of the class which was admitted to fellowship in 1935, to realize how decidedly the standards of admission to fellowship have been raised. In 1935, 549 surgeons were admitted; 14 per cent were admitted after an interval of 7 years following graduation, 9 per cent after an interval of 8 years, 12 per cent after an interval of 9 years, 49 per cent after an interval of from 10 to 20 years, and 14 per cent after an interval of 21 or more years. Four hundred eighty-one had obtained either premedical degrees or had done college work without obtaining degrees. It is interesting that of the 29 candidates who had had high school work but no college work before they entered medical school, the average number of years of practice following graduation was more than 20. Twenty-three had not served an internship, but of these, only 2 had been in practice less than 10 years between obtaining the M.D. and the F.A.C.S. degrees. Only one of the entire group had not had graduate work, assistantship, or residency after graduation. This rapidly increasing percentage of candidates who have had graduate training suggests that a continuation of a policy of gradually elevating requirements for fellowship is preferable to any plan of limiting the number of surgeons by setting up requirements so exacting that they can be met only by a favored few.

Inasmuch, therefore, as graduate training assumes more and more importance, the immediate problem which confronts the College and other organizations is the study of existing opportunities for adequate graduate training in those special fields for which qualifying boards have been or are to be established. In surgery, such opportunities are at present totally inadequate. Surveys of facilities for graduate teaching in surgery have been made by the College and will be the basis for further study of what may be finally suggested as minimal requirements. There can be no doubt that some standard of graduate training in surgery must be set up to serve as a pattern for those institutions which have adequate facilities, and the College offers its complete co-operation toward the determination of these standards.

The first problem in graduate training in surgery is the selection of candidates for such training. This selection is based on the candidate's personality, character, and physical fitness, his record in both college and medical school, his interneship, what can be learned from the staff of the hospital as to his qualifications for a surgical career, and, if he has been in general practice, whether or not he has been a success or a failure.

The length of time that such a candidate should spend in graduate training in surgery will vary according to the ability of the man, the character of the opportunities afforded for such training, and the purpose for which he intends to use his training. The intensive development of those fields which are not commonly included under general surgery, but in which the general surgeon must acquire reasonable competency, has apparently made it necessary that a minimum of 3 years be designed to fit a man for continuing further training in any one of the special fields of surgery, or for beginning general surgical practice, or for continuing for a longer period training of a type which would qualify him to engage in teaching. To accomplish these purposes during the 3 years, a minimum of 6 months should be given to intensive work in one of the fundamental fields, particularly in pathology, a minimum of a year in general diagnosis, and a minimum of a year as an assistant in general surgical services. Such a plan has shown that this is adequate training provided the man possesses the qualifications of a good surgeon, and provided that he has access to a sufficient amount of clinical material, is in continuous and most intimate contact with the teaching staff, and takes every advantage of the responsibilities and opportunities which are accorded him. As a matter of fact, however, such training has proved to constitute only a minimal standard, and for those who hope to confine their work entirely to surgical practice, or to find some opportunities for teaching, a longer period of training should be sought, this additional time to be given over to continued assistantship in which the major activities include, in addition to the duties of an assistant, certain further responsibilities in the teaching of the interne staff. During such a period of training, sufficient opportunity should be afforded to carry on experimental or clinical research so that any particular qualification he possesses in this respect may be developed,

and such research should be sufficiently comprehensive to be acceptable as the basis of a thesis. In addition, the character of the work done during the period of training, and both a written and an oral examination in the particular specialty, should constitute the minimal requirements for a higher degree which any adequate training should make possible and desirable. Such a plan does, I believe, stimulate the development of satisfactory graduate teaching in surgery more than does any other plan. The greatest obstacle to the widespread establishment of such a training may prove to be the difficulty of assuring those who have had such superior opportunities, that superior opportunities for applying their training will be available.

It is generally agreed that one of the outstanding achievements of the American College of Surgeons, in its efforts to give to this country the best surgical service possible with the existing conditions, has been its program for standardization of hospitals so ably directed by Dr. Malcolm T. MacEachern. The soundness of the minimal standard originally set up in the College is attested by the fact that little modification of it has been necessary. Standardization of hospitals has been far reaching in its effects, for as administrators of hospitals found that it was to their advantage in every respect to have their hospitals on the approved list of the College, the general efficiency of hospital service was enormously increased, particularly in respect to the care of the patient, and the confidence of the public in the modern hospital was greatly enhanced.

In addition to routine surveys, the College has rendered other service. The work of the Committee on Industrial Medicine and Traumatic Surgery, under the chairmanship of Dr. F. A. Besley, has done much to gain the good will of the leaders of industry and their support of the minimal standard for industrial and traumatic surgery which has been set up by the College. The same experience has been encountered in attempting to set up minimal standards for clinical laboratories and the treatment of fractures. A recent service developed by the College has been the assembling of motion picture films, which may be loaned to approved organizations for presentation to both the laity and the profession.

In the problem of the control of cancer the College has done much toward the education of both the public and the profession. Most effective results followed the registration by the Fellows of the College of a group of cases verifying the curability of cancer in its various situations. In a short time the records of more than 25,000 cases in which cures had followed surgery or the use of radium, or both, were reported. The wide publicity which was given by the press to this report had a most pronounced effect on the attitude of the public toward the disease and, in so far as the profession was concerned, this evidence of the curability of cancer, together with cancer clinics and the frequent symposia on cancer at annual and sectional meetings, have all aided in dispelling the too pessimistic view often encountered in the medical profession.

The past year Mrs. Franklin H. Martin, in carrying out the expressed desire of the late Dr. Martin, irrevocably trusteed to the College the property on Erie Street and the journal SURGERY, GYNECOLOGY AND OBSTETRICS. This journal, therefore, will become permanently the official publication of the American College of Surgeons, and the College has assumed the responsibility of giving its best efforts to maintain and develop its continuing influence in the advancement of medical education and science.

The proposal by Dr. George Crile, chairman of the board of regents, to establish a Hall of Science and Art of Surgery, in connection with the American College of Surgeons, has been discussed. It is believed that this Hall should contain progressive displays, and that duplication of those displays which can be found elsewhere should be avoided as much as possible. It should be a teaching museum in which exhibits of an educational value to the profession and possibly to the public would gradually be accumulated. It should be conducted so as to keep before the profession the progress of surgery and thus be a unique example of what America is doing in the development of this method of teaching.

The future of an organization which has had a wide experience in initiating and carrying on activities of such an educational nature as to improve the surgical service rendered to the people of this country should be characterized by even greater accomplishments than in the past. The mistakes which have been made by the College are insignificant in the light of the benefits that the College has brought to surgery, and the flexibility of the organization permits whatever adjustments may prove advisable to meet the changing order of the times, from which medicine cannot be exempt. The greater the familiarity with the purposes of the American College of Surgeons, the greater will be faith in its future, as has been so well expressed by Dr. Allen B. Kanavel in his address to the Fellows: "You have been chosen as representing the advanced surgical thought in your various communities. Whatever honor this

induction may signify, it imposes greater demands upon you for service. . . . Your organization is one devoted to self-criticism and self-improvement. Nowhere will you find that the College has arrogated to itself judgment upon the acts of surgeons or organizations outside of itself. We have, however, dared to say that after careful survey and study, we believe certain surgeons and institutions are worthy of public confidence and trust. Any authority we may have has followed from the sincerity and honesty of our purpose and actions. To you has been bequeathed this great heritage of public and professional confidence. You will be watched with jealous eye and the failure of any one of you to conserve the ideals of professional honor, of service to public, and of self-improvement will impair more than you realize, the prestige of the College." The College has accomplished much in the short period of its existence, and those who have been identified with the advancement of surgical practice as applied to the general population will find in the American College of Surgeons a most efficient agency through which their hopes may be brought to realization.

# THE EDUCATION OF A SURGEON: PAST AND PRESENT

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THE dominant objective of this great surgical organization is to direct the training of the surgeons of America, so that there shall be an adequate number for the various sections of the country, and these so prepared as to make them safe from the standpoint of the public. The achievement of this purpose involves the solving of many problems, among which are premedical training, general medical education, postgraduate study including specialization, and, finally, the limitation of the practice of surgery to those who are properly and fully qualified. Let us call upon the lessons of the past to help us in our proposals for the future. Let us in particular review the methods by which these problems, especially specialization and the qualification of surgeons, have been met under other conditions.

"Surgery is as old as human needs." Can one imagine a time when no effort was made to arrest hemorrhage, remove a foreign body, or immobilize a fracture? We know that the early inhabitants of this continent made use of trephining. Three to four centuries prior to the Christian era the Hindus, in an advanced state of civilization, practiced surgery on a highly developed and idealistic scale. It cannot be claimed, however, that present day technical surgery has been influenced by the distant past, because the introduction of anesthesia, and the knowledge of bacterial influences, quickly changed a limited craft into a vast science. On the other hand, the rating of surgery in the public mind, the standards of surgical education, the position of the surgeon in the community, have always been subject to change and vicissitude. To understand present conditions we must survey the road over which surgery has traveled.

An historical review shows great waves during which surgery and the surgeon were alternately held in high esteem and despised. These swings, like great pulse beats, are in part explainable. The practice of medicine and surgery has always been affected by the prevailing intellectual, scientific, and philosophical standards of the time, as well as by the habits and customs of a people. The Alexandrian schools, fostered by a practical, military, urban people were highly organized and surgery was surprisingly developed with emphasis placed upon anatomy, the employment of mandragora as an anesthetic, and the use of ligatures for the control of bleeding. Physicians and surgeons occupied an exalted position in the public mind. They held a similar position during the days of Greek predominance. But, after the Romans conquered the Greeks and Macedonians, philosophical and scientific thought languished and medical progress and standards correspondingly deteriorated. Their physicians, who were at first Greeks, were honored for a time but were later treated with contempt. Nevertheless inasmuch as the Romans were a military people, surgery was recognized as essential and it was relatively advanced. There were, however, no schools, and individual instruction was the rule. The period of study varied: Galen spent 11 years in preparation; on the other hand, Thessalus taught anyone to become a physician in 6 months. Unfortunately, records of these early times are meager. What would we not give to have details concerning the treatment of Crassus, the eminent Roman orator, who died of pneumonia or pleurisy? What would we not give to picture more clearly the successful extraction of a barbed arrowhead from the intrathoracic wound of Alexander the Great? In this connection let me emphasize the importance of the complete and permanent records which are now part of every hospital.

In the light of the modern tendency toward narrowing specialization, Celsus, a Roman author of the first century, stands out as an example. He evidenced a broad, non-specialized training, for he wrote with authority on farming, law, military tactics, philosophy, and medicine, his surgical discussions being particularly notable. We must commend as worthy of thought by the present day educator, the broad training and interests which this man possessed.

The dissolution of the Roman Empire arrested all scientific and medical progress. Under the barbarian hordes, medicine reverted to primitive levels. Among the German and other tribes, the monks became the healers; herbs were accepted as having therapeutic properties by reason of the belief that God or nature provided a remedy for every ailment; it was for man to find the remedy. Even among the more civilized peoples there was

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a decline in scientific thought. The rise of Christianity tended to turn attention from the mundane to the supernatural. As a result, sickness was generally regarded as a punishment, not as a natural phenomenon. The priest became physician, and sickness was to be escaped, if at all, only by prayer. Thus medicine, and particularly surgery, reached their lowest ebb.

The Arabs lifted medicine out of this abject state and gave the initial impulse to the development of modern medical education. Their influence steadily increased from the sixth to the tenth centuries, i.e., from Mohammed almost to the time of the capture of Bagdad by the Mongols, when Arab culture suddenly ended. The Arabs had hospitals and schools of a high order with special departments for different diseases. Candidates were required to pass examinations in order to practice medicine. Damascus, that "paradise of the earth" and "pearl of the Orient," became the dominating center of medical education. But the services of the Arabs to surgery were insignificant, first, because their religion forbade dissection, and second, because it was characteristic of the race to accept suffering with equanimity and to be unconcerned about its alleviation. The surgeon was rated on a low scale, almost as a lackey. Although the Arabs made original contributions to medical knowledge, their greatest accomplishment was the translation of the works of leading Greek philosophers and physicians, thus rendering available the knowledge of the past—the bequest of the ancient world. According to Neuburger, "The Arabs possessed far more of Galen's anatomical works than have come down to us; the great gaps in the original books have only been filled by means of the Arabic translations."

The medical standards and contributions of the Arabs left a mark in Italy, where, on the decline of Arabian culture, the foundations of modern medical education and surgery were laid. There, during the thirteenth century, medical education was systematized and anatomical knowledge was greatly extended. This progress was followed by serious and scientific physiological studies. To systematize medical instruction and requirements, Emperor Frederick II ordained that no man should be admitted to the study of medicine before he had studied logic for 3 years. We see in this an early appreciation of an intensive intellectual training prior to specialization. The study of medicine required 5 years. Then an examination was held, followed by an apprenticeship of 1 year. How similar to our modern system is this, namely, 3 years of premedical training, 5 years of medical school, and 1 year of practical instruction, comparable to our interneship. Notable steps were also taken to restrict the practice of surgery in order to safeguard the public. By the regulations of Frederick II, no one was permitted to practice surgery until he had shown by written testimonials of the teachers of the Medical Faculty that he had studied for at least 1 year such branches of medicine as would qualify him to do surgery. This comprised human anatomy and knowledge of surgical operations and surgical treatment.

Thus, in the thirteenth century, the laws made it impossible for any one not thoroughly trained to practice medicine, "at least in the more populous districts," showing an early recognition of the difference between rural and urban communities. The restrictions were due to an educated public opinion and to pressure from without. Let us hope that we ourselves will voluntarily make readjustments in the practice of medicine and surgery as changing social conditions and standards of living indicate and that we will not allow these changes to be determined by legislalation or other outside influences. The regulations of Emperor Frederick were widely adopted by later institutions, such as the Salerno and Montpellier schools.

At this time progress was based chiefly upon anatomical studies. In the first part of the Middle Ages, human dissection was not only forbidden by law but was also restricted by religious prejudice. The study of anatomy, therefore, consisted for the most part in animal dissection. Dissection of human cadavers was not generally introduced until the sixteenth century. In the beginning the professor from a pulpit described the parts, the dissection being performed by a surgeon or barber. The manner in which such anatomical instruction was presented is illustrated in several paintings of the Dutch school. But the Italian anatomists themselves performed the dissections. Thus they acquired a more vital and intimate knowledge and we find that virtually all the prominent anatomists of the time received their education in Italy.

Considerable attention was devoted to the study of the circulation, notably by Realdo Colombo, successor to Vesalius in the chair of anatomy at Padua. When Vesalius, in 1542, went to Basle to further the printing of his monumental anatomical work, Colombo was appointed his successor. It is said that he dissected about 14 cadavers annually and that he was the first to use dogs for vivisection. His most notable contribution was a description of the lesser circula-

tion. It is a question, however, whether the credit for this should not be given to Servetus who would then become the real forerunner of William Harvey. Padua in the sixteenth century had conspicuous surgeons as teachers, notably d'Aquapendente, a pupil of the anatomist Fallopius whom he succeeded (1565) as instructor in anatomy. He built at his own expense a large anatomical theater where he held forth to huge gatherings of students from all countries. We see here a great scholar, a great personality, swaying and impressing an attentive mass of young men. Has not this something to commend it? Do we not discount today the influence which might be exerted upon the young man by outstanding personalities in the profession who might well be introduced to him in the amphitheater? Surgery as practiced in Italy at this period was presented by Giovanni Antonio Della Cruce of Padua in a classical textbook, published in 1573, which was a standard work for more than two centuries. In it trephining is extensively discussed; the text is accompanied by illustrations of the instruments employed for the operation, many of which are almost identical with those used today.

Beginning with the middle of the fifteenth century, students from all over the world went to Italy, especially to Padua and Bologna, just as a few decades ago we went to Vienna, Edinburgh, and Berlin. And what extraordinary products resulted from such migrations! Among those who were influenced by the Italian schools, for it is always a stimulus to dwell upon the great men of the past, may be mentioned Linacre who graduated in medicine from Padua. Afterward he introduced the medical sciences into England where he became physician to Henry VIII. He left a fortune to establish the Royal College of Physicians in London, 1518. Caius, who also studied in Padua, advanced the study of anatomy in England. He obtained annually from the authorities the bodies of two executed criminals for dissection. He was court physician to Queen Mary and Queen Elizabeth. William Harvey, immortalized through his discovery of the circulation of the blood, matriculated at Padua in 1598 and received his diploma in 1602. He became court physician to James I and Charles I.

During this period of Italian predominance, France was also progressing. In the thirteenth century there occurred a development which may be regarded as the precursor of modern surgical societies and colleges. This was the organization of the Collège de St. Côme by the surgeons of Paris. Regular meetings were held for the discussion of professional and educational subjects and students were instructed. Later, as a result of the influence of such men as Lanfranchi and Guy de Chauliac, the French became the leaders in surgery, a position which they held until the middle of the nineteenth century. The pupils of the Collège de St. Côme acquired a scientific education equal to that of the physicians, but socially they were regarded as inferior. The dispute between physicians and surgeons lasted until the beginning of the eighteenth century. It is said of John Hunter that "more than any man, he helped make us gentlemen."

About the seventeeth century modern scientific methods of thought and medical education may be said to have taken root. Francis Bacon wrote: "Medicine is a science which has been hitherto more professed than labored and yet more labored than advanced: the labors spent on it having been rather in a circle than in progression."

He criticized specifically the scant progress in the treatment of disease and in the prolongation of life. An outstanding indication in his analysis of medicine may be given in his words: "That utility may be considered as well as humanity, the anatomy of the living subject is not to be relinquished—since it may be well discharged by the dissection of beasts alive." Bacon forecast the importance of pathological anatomy.

The development of scientific thought and inductive reasoning was destined to control and minimize superstition and reliance upon the supernatural, which had always interfered with medical progress. The people had never recognized medicine as a progressive science. Their faith for centuries had lain in "healers" of one kind or another—witches, medicine men, and the spirits of departed saints. For instance, in 1562, Don Carlos, Prince of Spain, suffered from erysipelas. The King and Vesalius were summoned. When the patient's recovery seemed hopeless, the relics of St. Diego, whose body had been brought in with great solemnity, were placed by the Prince's side and improvement immediately set in.

During the seventeenth century medical education became greatly broadened. Previously it had been based upon theoretical lectures by leading authorities. Gradually the sciences, chemistry and physics, were included; greater emphasis was placed upon anatomy through dissection, clinical instruction was given in hospitals, and, finally, independent work was encouraged. Yet it is astonishing how slowly practical instruction developed, since its value was recognized years before it was generally adopted. Bedside teaching was encouraged by the Medical

Faculty of Paris as early as 1449. However, the University of Leyden appears to have been the first to establish permanent clinical instruction; this was about 1630. The student took a history, made a physical examination, and registered his diagnosis; then the professor confirmed or refuted it. Boerhaave, who later became head of the University of Leyden, should be remembered for his efforts to develop this feature, which is the basis of our modern bedside teaching.

Early American medicine was dependent upon the developments which we have attempted to describe. John Morgan, after spending 5 years in Europe, became imbued with the importance of organized medical training with which he had become familiar abroad and, on his return, delivered his famous "Discourse upon the Institution of Medical Schools in America" (1765). As a result of his influence a medical school was founded in Philadelphia, the first in this country. Foreign influences were likewise responsible for the founding, some years later, of the College of Physicians and Surgeons in New York.

The details of the subsequent development of medical education in America need not be reviewed. Initially, the profession was composed of serious-minded men of culture; but gradually social climbers, quacks, and charlatans became more and more numerous. There sprang up innumerable commercial institutions and third-rate schools which issued a degree for a few dollars after a few months of instruction. We may look with pride on the fact that as a result of the efforts of the medical profession during the last 50 years, we have gradually worked back to high standards; I am tempted to say, to the same relative standards that prevailed in the thirteenth century under Frederick II. The profession no longer needs to struggle for existence. People are so convinced of the efficacy of medicine and surgery that miracles are expected from the doctor, not from the faith healer. Formerly, a cure by surgery was greeted with prayerful gratitude and amazement; now it is taken for granted, and failure to effect a cure is a cause of surprise. But the millennium has not been reached. We must admit that defects in our system still exist and we must ever earnestly strive toward their correction.

Let us summarize present day problems, some of which are unique. The field of surgery has been enormously extended, so that "no part of the human anatomy is immune from the surgeon's scalpel." But into this wide field have been injected risks of misapplication. The practitioner of medicine now holds a high place in the social scale, and the surgeon is more highly esteemed than at any time in history. It is not surprising, therefore, that this social and economic factor influences young men in their selection of medicine as a career. Yet, the controlling impulse is, for the most part, humanitarian. To foster this idealism in the young and to effect the best results, a broad general education rather than premature specialization should be the aim. The premedical requirements are too highly specialized and need revision. My reasons for this statement as well as for other criticisms of our modern system of medical education, have been outlined in a recent address and need not be repeated here.

Undergraduate medical education has been well organized and standardized. It supplies an adequate number of trained men for the care of the sick and the prevention of disease. The student is taught to think and reason rather than to memorize as of old. Perhaps undue weight is being put upon research as an objective. Research should be inspired by an irresistible search for truth, and should not, as is so often done, be undertaken for self-exploitation.

With the completion of the undergraduate course, i.e., the attainment of a medical degree, certain factors in the present system for further training give rise to just criticisms. Almost all graduates take an interneship. But we must face the fact that no interne system has proved wholly satisfactory. I believe that this is one of the most important subjects for study and readjustment. Under the average resident system, the interne wastes much of his time; under the old-fashioned and usual system, the interne gets more opportunity than he can digest, and at the expense of others who could properly profit thereby. Under both systems there is too early specialization. Every surgical aspirant should have at least one preliminary year on a general medical service and should at some time receive instruction and experience in the psychiatric aspects of general hospital practice—two features which are ordinarily neglected.

There is perhaps a growing tendency to slight pathology and physiology throughout all the developmental years. The laboratories of a hospital should be so laid down and administered as to attract the clinician on his daily rounds. Intimate contacts between clinicians and laboratory workers should be encouraged. Without such a close union and atmosphere the scientific progress in an institution will quickly wane.

The young man who is ready to embark on practice finds the field of medicine overcrowded,

and particularly so the field of surgery. This condition is most marked in the densely populated areas; therefore, efforts should be more active to induce recent graduates to enter country districts.

The enormous development of the knowledge of disease and the technical details of treatment have made specialization necessary, but it has been overdone. Measures are indicated to require of every specialist a broad general preliminary training.

We all favor extension of studies beyond prescribed interneships, but the expense prevents many promising candidates from pursuing such a course. Fellowships should, therefore, be more generally available, and greater efforts should be made to obtain endowments for this purpose.

A Goettingen physician in 1420 left 600 florins, the interest to support a poor medical student for 4 years in Montpellier. Although this was an act of benevolence, I cannot but feel that it is the graduate or fellow rather than the undergraduate for whom funds should be made available. It were better to make the men who are already in medicine as useful as possible rather than to tempt others into an already overcrowded profession.

While present day surgery is, in general, on a high standard, there is some commercialism, evidenced by excessive charges, too radical and unnecessary surgery, and fee splitting. The public and the profession are frowning more and more upon such practices, and idealism and altruism are becoming increasingly the dominating motives. If conditions are to be fundamentally improved, the young must be influenced. This is difficult under our present educational system. The obligation is a heavy one; it is one which must be borne chiefly by the teachers in our medical schools.

The weakest and least developed feature in medical education is postgraduate surgery. It is impossible under present conditions to provide operative instruction. Only extensive practical experience can qualify a man to operate with safety to the patient. Theoretical postgraduate courses which include the viewing of, and even the assisting at, operations give a man a degree of self-confidence which is dangerous. In the early days of American medicine, operative clinics were mainly utilized for surgical instruction. They were widely attended and were often spectacular affairs. In visiting operative clinics I have often been impressed by the fact that they are relatively useless for purposes of instruction, and that from a humanitarian point of view, as Cushing has pointed out, they are ill-advised. "Operations," says Flexner, "are performed in large amphitheaters in which the surgeon and his assistants surround the patient, to whom they give their whole mind, in practical disregard of the students, who loll in their seats without an inkling of what is happening below. Most of the students see only the patient's feet and the surgeon's head."

But graduate training in surgery must be provided. There should be a carefully directed and supervised apprenticeship, in which the graduate actually participates in practical surgical work. Such a graduate course should not be merely a classroom, operating room, and laboratory function, and it should not be confused with postgraduate study, i.e., the further pursuit of an already acquired specialty. Whenever possible it should embrace continued study of the basic medical sciences, such as anatomy, physiology and pathology, and the auxiliary clinical branches, such as radiology. The great teaching centers and medical schools are inadequate for this purpose.

There are, however, almost unlimited facilities in the non-academic hospitals throughout the country. These should be organized and used for the purpose, a feature which is well within the province of this College. The present form of interneship is wasteful and should be modified so that the material will be shared between internes and other graduate students, such as fellows. The latter should be accepted for a relatively long period and should be allowed to operate under instruction and supervision. The character of their work and their personalities should be carefully weighed in the decision as to their qualifications as surgeons.

The public must be protected from the incompetent and casual operator. Before embarking on a surgical career, a man should be required to have something more than a medical degree. A certification or registration based upon training, character, and ability should be obligatory. The qualifying and examination of a candidate should be the function of the profession. We may feel encouraged by the fact that much progress in this direction has already been made and we may justly anticipate an era in the near future when this ideal will be attained. But we must continue to work diligently toward one end, remembering the words of the poet:

> Ye rigid Ploughman! Bear in mind
> Your labor is for future hours.
> Advance! spare not! nor look behind!
> Plow deep and straight with all your powers

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# MEDICAL PRACTICE AND THE LAW

## Some Parallels, Relationships, and Problems

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Fifteen years have passed since my period of service, in 1921, as Acting Associate Director of the American College of Surgeons. In that time fifteen groups of surgeons have completed eight years of practice subsequent to professional training and have been admitted to Fellowship. There are, therefore, many new faces before me. During all of these years my interest in the American College of Surgeons has continued, and I have had on several occasions the pleasure of actual participation in meetings. The last meeting, however, in which I took part, in Oakland, California, in 1931, antedates the passing from the activities of the College of two men (one on account of his death and the other on account of ill health) with whom I was closely associated in my own day of service with the College, the imprint of whose character and leadership was so definite that it persists, and will persist, to give character permanently to the work of the institution. I refer, of course, to Dr. Franklin H. Martin and to Father C. B. Moulinier, until a few years ago the president of the Catholic Hospital Association. These two men, differently educated, one for the medical profession and the other for the clergy, of different religious faiths, nevertheless had a common allegiance which made them friends and fellow workers. This common allegiance was an allegiance to science and to the intelligent and ethical carrying of science into the relief of human suffering through the medical profession and its agency, the hospital. And these two men had also in common an extraordinary courage, a courage founded upon their allegiance to the truth and their belief that the truth can be made to prevail in the affairs of men. It was this that made them friends and that explained their indomitably persistent efforts toward the accomplishment of objectives which to nearly all others seemed impossible. I think we all recognize that the existence and the persistence of this institution are in large measure due to Franklin H. Martin. That he had great help from great friends need not, of course, be said, and he could not have succeeded without them. But they all, I am sure, join me in recognizing the greatness of his leadership. And without the interest and the courage and the work of Father Moulinier, it would, I think we all realize, have been well nigh impossible to carry the cause of hospital standardization into the Catholic hospitals of the United States and Canada within the space of the few short years in which that was actually accomplished. That the great Catholic hospitals, comprising as we know the majority of the hospital beds of the continent, would ultimately have recognized the merit of the program, I do not doubt, but we owe to Father Moulinier their early and active and friendly attention to it. We have, of course, had similar friendly help in respect of the Protestant hospitals to whom also our program needed a friendly introduction. But even in this aspect of our task, the wisdom and genuine friendliness of Father Moulinier was of great help.

I should be remiss in my duty to friendship to these two great men did I not this evening in preface to my formal address, pay tribute, as I do, to their service, to their great friendship for science and for humanity through science, and to their faith and their courage.

I

IT IS platitude that modern medicine is scientific: It has through observation, aided by experiment, assembled a body of facts and principles and it uses them rationally in the prevention, diagnosis, and cure of disease. It is based upon natural laws disclosed through the development of fundamental branches of scientific learning, in particular physics and chemistry, anatomy, bacteriology, and pathology, and their subdivisions. It is scientific in a further sense, in that it has devised and brought to use many physical, chemical, and mechanical agencies and routines—drugs, disinfectants, antiseptics, chemical tests, measuring devices, therapeutic and operative, and statistical methods. It is equally well known that modern medicine is highly organized. The profession is organized as a whole in the American Medical Association, and

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its two great comprehensive specialties are organized into the American College of Surgeons and the American College of Physicians; its less comprehensive specialties are organized into their special societies. These organizations act as agencies for the exchange and dissemination of scientific information, and operate to originate and promote proper professional policies and standards—all for the good of the public and the profession. Medicine is organized further in that in the actual practice in the profession at large there is informal co-operation through consultation between practitioners, through reference of patients to specialists, and through use of laboratory and technical services; and there is formal co-operation of similar sort in the organized groups or clinics and in the hospital, where the whole scientific knowledge and technical equipment and method of the profession are focused and where they function for the mutual advantage of doctor and patient. The hospital itself exists and functions through organization—organization in the corporate sense, and organization of the services of hospital administrators and their assistants, both lay and religious, and of the services of the great nursing group. Within the organized aspect of the profession are also to be mentioned the medical school and research foundation for the discovery and dissemination of knowledge, the pharmaceutical establishments of learning, manufacturing, and distribution, and the establishments which manufacture the various instruments of precision which are used for the discovery and the understanding and treatment of the disease.

While these aspects of medicine and its practice are obvious, they are not so generally recognized as characteristic also of the law. Yet in a very real sense the law is scientific and its practice organized. While the law does not rest upon foundations of natural laws, such as characterize the properties and functionings of matter, in exactly the same sense as medicine, there nevertheless is a science of jurisprudence. Law is a science in its possession of organized knowledge and principles. Legal systems have structure and function, and the facts and principles thereof have been observed and brought to book. There is an anatomy of law in its structural, substantive, side, a physiology of law in its adjective, procedural, side, even an embryology of law in its development from archaic types whose rules are formal and modes of trial mechanical, to matured and modern systems whose rules are functional and whose modes of trial are pragmatic. The physical or natural sciences cannot monopolize the term science. Indeed, they have only recently adopted it. What are now called chairs of biology were, within the memory of the generation before us, chairs of natural history or natural philosophy. Nor can the sciences, usually so called, claim to monopolize validity in their formulas. "Laws," based upon the observed phenomena of the cases in the courts, are as valid as the formulas of chemistry or engineering. The formulas of these applied sciences control the conduct of matter. "Laws" control the conduct of men. The physical sciences have an advantage in that they deal with matter and can keep materials safely within their formulas. The materials of the law, men in action, are always struggling against the limits of legal formulas. The formulas of the chemist and engineer and physician are formulas whose purpose is to get things done. In the large the formulas of the law are to keep things from being done. Law is scientific, also, in having devised operative agencies and routines for its application —courts and commissions.

It has been said thus far that modern medicine is scientific and organized and that law, too, may make some valid claims to be a science. It is also organized, and in much the same manner as medicine. It has its great society, the American Bar Association, suborganized into sections of international and comparative law, administrative law, patent law, insurance law, real property law, criminal law, and the like. These organizations, like the parallel societies in medicine, act as agencies for the exchange and dissemination of legal information, and operate to originate and promote proper professional standards and policies. The law in practice is divided into specialties, and these specialties co-operate informally through consultation and reference of clients, and formally through great law firms paralleling the formal groups and clinics of medicine. Courts and commissions are the hospitals, or operative theaters, of the law where legal knowledge and procedures are focused, and where they function for adjudication upon social disease in the form of controversies between man and man and man and the state; the courts have their officials and their juries. The law has its schools and foundations. And to complete the parallel it has its establishments for the reporting of its cases, and the production of its manifold indices and other written aids.

II

There is a further parallel between medicine and law, one resulting from the scientific and organized character of each. Medicine and law

have contributed greatly to the prevention and resolution of human suffering and human controversy. The record of medicine leaves no doubt of this. Plagues have been brought within control, the death rate lowered, morbidity decreased, life extended, life in the modern manner and on the modern scale in great urban centers indeed made possible, by medicine. The legal record is the same. The law has reduced the plague of anarchy to civil order, substituted the court and the sheriff for the fist. As an engine of social control the law guarantees fundamentals of worth while social life. In the words of the preamble to the Constitution, domestic tranquillity, the common welfare, the blessings of liberty, are had through the law. Alongside this parallel of contribution to human welfare by each of the two professions, indeed, promoting such contribution, has been an interrelation, or mutual support, between the professions. Medicine has contributed to the maintenance of civil order and civil order to medical relief. Sanitation and quarantine and lunacy laws aid medicine to control disease and to help in the prevention of violence; licensing statutes (since the statute of 3 Henry VIII cap. 2 whose preamble informs us that "ignorant persons, who could tell no letters on the book, and common artificers, smiths, weavers, and women, who took upon themselves great cures, partly using sorcery and witchcraft, partly applying very noxious medicine to the diseases," were practicing medicine) aid the scientific physician and protect the public, as do also the rules supporting the confidence between physician and patient. Where medicine has aided the public, the law has aided medicine.

III

We live in an age in which science and organization are lesser gods to all and, unhappily, substitutes for God Himself to some. Science and organization are on the pages of every book, on every lip. It should follow as the night the day that since medicine and law are scientific and organized and co-operative, they must stand high in public regard. But the truth is somewhat to the contrary. The laity shrugs its shoulders; it is skeptical of medicine and law, even hostile. Since we are scientists it will be of interest to examine some of the phenomena of complaints about the two professions. Perhaps, let us hypothesize, we shall find another parallel, and perhaps a common cause.

A first and general complaint against medicine is that it is beyond the reach of the mass of the people, that only the poor and the well to do get the best or sufficient medical attention, that physicians' fees and surgeons' fees and laboratory fees and drug fees and hospital fees and nurses' fees put medical relief beyond the reach of the average man, that to save one's life one must mortgage it. The profession is not Samaritan, it is commercial, say the laity. Even the well to do complain. They charge that the profession charges what the traffic will bear; that under a specious plea of charity the doctor gets paid for his charity by levying an involuntary tribute upon the well to do sick. And so they say that if the well to do are to be levied upon for the poor, let the levy be not a tribute but a tax, and a tax laid not merely upon the well to do sick, but upon the well to do well—upon all, a general levy, not a special one. There is a similar complaint about the law. While according to the canons of the legal profession "a client's ability to pay cannot justify a charge in excess of the value of the service, though his poverty may require a less charge or even none," this differentiation lessens little the clamor of the public against the costs of the law: The poor, it is said, cannot afford lawyers and courts, therefore justice is denied. Even those who can afford the law assert that the rich get more justice than the moderately well to do by hiring cleverer lawyers, or greater firms with their legal specialists and facilities. The great fees for the receivership lawyer are under attack, as are the great fees for the salvage services of the doctor.

A second and almost equally general though perhaps not so clearly phrased complaint against medicine is that it has become depersonalized, remote. No longer, cry the laity, is there available the comfort of the family physician. For him has been substituted a galaxy of specialists through whose hands a patient is passed as on a belt in a factory, each workman taking a look and a cut. This complaint (and some others) is phrased in a recent weekly[1] as follows:

TURN ABOUT

(The automobile mechanic, who has been to several doctors in his time, has an opportunity to turn the tables).

"Good morning. Will you look at my fan belt, please? It seems to have come off."

"Ah, yes, doctor. Have you ever been in this garage before?"

"Why, no, I don't believe I have been here before."

"Well, then, it will be necessary to take a brief history before we can proceed. Just routine, you understand, doctor."

"But listen! All I need is a new fan belt! Merely a matter of seventy-nine cents."

"One never knows, doctor. We had a fan-belt case in here last week. Owner just wanted a new belt quick, and

[1] The Saturday Evening Post, September 19, 1936.

hurried away. This morning we got an emergency call to his home. Differential had dropped out. Very sad."

"Great Scott!"

"Tell me, do you have trouble starting in the morning?"

"Well, cold mornings, it sputters."

"Very significant. Well, suppose we have a look at that fan belt now."

"Here it is."

"Tch, tch, tch! I must say, doctor, I don't like the looks of that fan belt. Not for one minute, I don't. Fortunately, it's a clean break. But any one of a number of complications might set in. With your permission, I'd like to have Mr. Axel Johnson, of the Acme Garage, see this fan belt. He's one of the best fan-belt men in the country today."

"All right. If you say so."

"And, while we're at it, I'd like to have Frank Smith, of Commercial Service, look into the block, too. He can tell us a little something about that piston slap. Better to be safe than sorry, eh, doctor?"

"Well, all right. When can we do all this?"

"Let's see. I'm doing a rebore this morning and a valve-grind and rear-end reassembly this afternoon. How about 9 a.m. tomorrow?"

"All right."

"I may be a little late. I'm tightening a connecting rod at 8, but you can sit in the office and read the back numbers of the Auto-Mechanic's Journal."—DOUG WELCH.

No longer, it is said, does any single doctor feel an interest in, friendship for, responsibility with respect to, a patient. Again, in specification of this charge of depersonalization, it is alleged that the patient is ripped from his bed at home, carted by strangers to a factory-like hospital, entered as a statistical unit upon a case history by a cocky interne, secreted and lectured upon in operating or delivery room, denied in a crisis of life the solace of the presence of those near and dear; such sympathy as is good for the patient is, so it is said, ladled out like medicine, in measured doses, by a nurse starched and stiffened to the task.

So, too, it is charged of the law, that it is depersonal, remote: The general practitioner, the guide, philosopher, and legal friend in business and family affairs is largely replaced by the office lawyer, the trial lawyer, the corporation lawyer, the patent lawyer, the tax lawyer, the probate lawyer, the real estate lawyer, the criminal lawyer, cry the public. The client, detached from the friendly surroundings of home or office, is jailed or hailed to hearings by rough strangers, publicly harangued and probed, in business and personal affairs, by calloused lawyers, frowned at by stern judges in gowns, tossed to the mercy of juries, passed like a raw material through the whirring machinery of pleadings and arguments and verdicts and judgments and motions for new trials and appeals and precedents, written about in the foreign jargon of opinions, and turned out finally a thoroughly finished product.

A third charge against medicine is that for all of its pretentions to science, it is not scientific, but as uncertain in its results as the magic of the witch or the art of the clairvoyant or the incantations of the medicine man. Say the laity: Bunions are cut off only to grow again; tonsils are chopped out and teeth pulled to cure growing pains; appendices, diagnosed ruptured, are excised mildly inflamed; peritonitis is called intestinal "flu"; benign tumors prove malignant and malignancy benign; obstetricians, be-gloved and be-sterilized and be-instrumented, cause infections as often as midwives—whose only aid is nature.

And again there are cognate charges against the law. Say the public: The guilty go free and the innocent to jail; the gangster-murderer is convicted of income tax fraud; law suits are gambles; justice is thwarted by technicalities; the only certainty about the law is its confusion.

A fourth charge against both professions is narrowness: Prejudice blinds the eyes and orthodoxy the mind of doctors to the discoveries of Columbuses of science known in conventional medical parlance as "irregulars." Lawyers are blind to social and economic change, and deaf to the entreaties of the people for the simplification of legal procedures and for the elimination of the delays which are denials of justice. Medicine is chained to the past by convention, law by precedent, so it is charged.

As doctors, respectively of medical and juridical science, we know that most of these charges against the sister professions are exaggerations or distortions, exposures of incidental defects or abuses and concealments of greater virtues, enumerations of by-products without reference to major output, even falsifications. Briefly reviewing the complaints: In respect of narrowness, they fail to take account, concerning medicine, of the fact that the history of the development of scientific medicine is a history of frank recognition and repudiation of the errors of the past and a history of sure, if gradual and conservative, absorption of scientific truth, whatever its source; they omit to consider the substitution of the findings of Pasteur for the guesses of his antecedents, the repudiation of the manifold pharmacopeia of the past and the reduction of drugging to a few specifics, the adoption and development of the rubbings and heatings and bathings of the masseur into the physical therapy of the modern hospital. Concerning law, they fail to consider the substitution of trial by evidence for trial by battle, of public hearing for star chamber, the liberalization of the law by equity, the adoption for industrial injury of the doctrine of liability without fault, the rejection of a jurisprudence of dry concepts, and the acceptance as a test for the

validity of rules their just social operation and effect; they forget the development of preventive remedies, the declaratory judgment, the juvenile court, the agencies of probation and parole.

In respect of the assertions that medicine and law are uncertain: These charges count the negative cases and omit the affirmative ones; they look at the present without comparison with the past. In medicine they consider the few patients who die, not the many who recover, the lives shortened by cancer despite the knife, not those saved or prolonged by preventive excisions. They omit to compare the guesses of yesterday with the diagnostic precisions of today, or the old treatment of symptoms with the new of causes. As concerns the law, the complaints count only the fraudulent divorces and the delayed trials and the escapes through technicalities, and not at all the manifold and precise services of the law to the machinery of business, and the vast number of cases, justly tried by honest and effective judges and juries, determining controversies promptly.

The charge that the professions are depersonalized by the elimination of the family physician in medicine and the general practitioner in law, and by development of the specialist in both, and of routines and records and hospitals and courts—omits to consider that life moves forward, not backward, and that the increase and ramification of knowledge compel division thereof and division of labor in its application, and this not merely in medicine and law, but in engineering and in business and in teaching and in art and music and literature. This charge forgets that life is growth and differentiation, not stagnation or retrogression.

Finally, the complaint that the professions are mercenary forgets that in medicine and law as in business there is overhead, that education and instruments, and laboratories and courts and commissions are inevitably costly; it forgets also that the majority of doctors and lawyers have modest incomes and devote themselves to their callings and the service of man therein as ends of which the fee is but an incident.

IV

But to resume our scientific quest. We have found a parallel between medicine and law in science and in organization, and a further parallel in the boons which they have rendered humanity, and a still further consonance in the phenomena of the complaints against each. We must admit in frankness that in respect of two of them—that bigness and specialism have appreciably depersonalized medicine and law and that neither serves as fully and economically as is desirable, the wants of the whole people—there is some truth. Is there a common cause, and if so, what?

A laconic characterization of the cause of the ills of today, medical, legal, social, economic, governmental, is that what is too big is no good; that society and the professions must look for the cure of their ills to simplification of life and its agencies. Conceivably this is the cause of our professional deficiencies; conceivably modern medicine and its methods and instrumentalities and modern law and its rules and methods and institutions have become Gargantuan. Possibly we have built up not a kindly giant of knowledge and technique to serve, but a heartless Frankenstein to destroy. It is doubtful that this is the cause. Each forward surge of the evolutionary tide has differentiated life, not simplified it, whether we speak in terms of biology, sociology, economics or government, law or medicine—yet life has persisted. And if this is the cause, the cure is hopeless. Life does not resimplify itself except by disintegration.

The cause is a different and a deeper and a more hopeful one. In art, in music, in literature, in medicine and in law, there is the eternal problem of substance and form, of the idea and the means of its expression. The painter's pigments have no significance in the tube. Only as they are combined for color and arranged according to a drawing does a landscape appear. The theme of the composer of music must be spread upon the page and sounded in the voice or instrument if there is to be music. The letters of the alphabet must be arranged into words and the words into sentences or stanzas, if thought or feeling is to become understandable. So also the body of knowledge in medicine cannot function for the patient except through the medical school, the test tube, the x-ray, the case history, the hospital, the instrument, the therapeutic method, the operative technique, and in some degree the specialist. And so in the law the body of substantive law is carried into effect for business transactions through contracts, notes, articles, and the like, and for the solution of controversy through pleading, evidence, procedure, court technique, and the rules thereof—and again, to some degree, through specialists. Unless the water of knowledge, first collected in the reservoirs of the mind, passes through the canals of instrument and institution, it never reaches and satisfies the land of human need. This dual aspect of life is not escapable. Without form substance has no significance and without substance form

is empty; and there must be both substance and form, or instrumentality, for function. The problem is not one of escape but of balance. Too much form may overwhelm the substance, as too many words the idea. Too little form may leave the substance inarticulate, unexpressed. If the canals are too few or too short, the water will fall short of its goal; if they are too many and too long, it will be dissipated. Form and instrument will have defeated the very substance they seek to express. So with medicine: Overspecialization may break up the substance into so many fragments that they cannot be united for the cure of disease. If education and research, and hospital and laboratory service, the machinery of medical practice, builds undue overhead, scientific knowledge will be too costly to reach the patient. So with the law: If the rules and the documents are too many or too specialized, and pleading, evidence, procedure, and court functioning too complicated, justice will lose its force. If the organizations of the law, the firms, the courts, build a burden of expense beyond the reach of the common man, justice will be denied him.

V

A not unusual topic for a lay address to physicians and surgeons is that of exhortation to improved technique, to a heightened standard of practice ethically, and to co-operation in the organized functioning of the professions. The desirability of these objectives is not to be minimized, but their accomplishment should be taken for granted in respect of Fellows of the American College of Surgeons. I have for several reasons chosen as a topic proper for the attention of those who are assuming their gowns, degrees, membership, and responsibilities in this organization committed to leadership in solving the problems of the profession, the subject of the current complaints against medicine and law: As a layman to medicine, I hear these complaints more fully and frequently stated by other laymen than do members of the medical profession; as a layman whose interest in and friendship for the medical profession and for this organization has long been known, I can speak frankly; and I regard the complaints as worthy of serious attention.

As has been pointed out above, the charges divide themselves, in the large, into two classes—those which are untrue, or which are distorted, or exaggerated, and those which are in some part founded on fact. Both such types of complaint deserve attention. In respect of the first: It may be said that to friends of the professions explanations are unnecessary, and that to enemies explanations are of no avail. But the people are not our enemies; and this doctrine of dignified silence can be carried too far in respect of enemies and friends alike. False or exaggerated or distorted charges, if never answered or explained, may come to be thought of as true. A voice should be lent to good at times, if voices lent to evil are to be silenced. We take too comfortably for granted in respect of medicine and law that their virtues, which we know to exist, are so clear to all that they need no demonstration and no proclamation. The leaders of medicine and law ought, I suggest, concertedly, and often, and vigorously, to bring to the attention of the public the essential merits and services of the professions, and the false, distorted, and exaggerated character of many of the charges against them.

Respecting the second class of complaints, those having some foundation in fact: To the extent that the truth is against us, let us face it and mend our ways. To reform is to preserve. The people, for the most part, still seek their remedy of the professions' ills through the professions. But if the professions do not effect a cure, the people will try alone to do so. Support by the public of medicine and law, as presently constituted, rests upon public good will.

We must, therefore, face this problem of bigness, this danger that the formal or procedural side of medicine and law will overshadow the substance, crush the effectiveness in medicine of scientific relief, and in law of justice, for the mass of the people, this danger that science and organization will themselves obscure and obstruct the personal Samaritan element without which both professions would be as the shell without the kernel. We must learn how to develop and expand the body of scientific knowledge, and to carry it rationally through the minds and processes and machinery of our vocations into the service of man, without such bigness and ramification and detail of knowledge, process, and machinery and without such depersonalization and expense as to defeat the end we seek, which is simply to serve man well and to serve him kindly. We must make medicine and law scientific enough and big enough and specialized enough and organized enough and, in the sense of possessing a sound sense of values, impersonal enough, to be useful, without making them so scientific, so big, so specialized, so organized, and so remote, as to be useless. We must save science and organization from themselves, save the systems from their incidents of evil.

I do not assume to be able to solve the difficult problem of substance and form and balance as it presents itself in medicine and law in terms of the

incidental evil consequences of science and organization. But I venture to suggest a method of solution. It is not a far away and miraculous one, nor a short cut to Utopia, nor even a novel method; it is the familiar and laborious and fearless method of organized science itself. The method of organized science is a valid one. This being so, it must be valid to deal not only with disease extrinsic to organized science—the ailments of the human body in medicine and of the body civil in law—but also with its own ailments, the defects of its own body and function. Need I repeat the method of science to this audience? It is simple—to observe phenomena, to collect and classify the facts thereof, to note sequences, causes, and effects, to draw out principles, to embody them in formulas, process, and machine, and then impersonally to apply the knowledge of fact and principle thus gained to the control of matter. This method we must apply to the problems of our professions. We must observe the phenomena of the expense of medical and legal relief, of depersonalization through elimination of the family doctor and the general practitioner of law and through the building of a galaxy of impersonal specialists and clinics and hospitals and courts and commissions, and we must classify the facts, and study causes and effects, and draw out principles, and devise formulas and methods, and then fearlessly and impersonally cure, by means of the knowledge and the skill thus gained, our own ills. Physician and lawyer, know and cure thyself. This, without doubt you can do. Medicine and law are devoted to the great trinity that underlie all worth while accomplishments—to truth, through science, to goodness, in the kindly service of mankind, to beauty, in the ideal of a perfected workmanship. With such allegiances, and with organized scientific effort on the part of the professions, their ills can and will be cured.

# THE ART AND SCIENCE OF SURGERY

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IN THE battle between life and disease, the surgeon steps into the battlefield like a *deus ex machina*. He operates and the battle is decided. The tussle may have gone on for weeks and the vicissitudes of the struggle may have see-sawed back and forth for long periods. When the surgeon comes upon the scene, the tussle is decided, the see-sawing ceases, the sentence of life or death is pronounced. It is this advantage which the surgeon has over the internist, that his appearance and his actions and his effects are dramatic. In the popular mind, he is the thaumaturgus, the miracle man of medicine. The internist may have slaved over a recondite problem in diagnosis for weeks, balanced a physical finding against a laboratory report, weighed the medical probabilities in an ambiguous roentgenogram, even though it be stereoscopic, interpreted and re-interpreted a fever or a blood sugar curve, but the surgeon steps in to claim the credit for the recovery. The patient suffers under the attentions of the internist. He cannot understand palpation, percussion, and auscultation, the stereoscope and the manometer and the blood counter and the graduated syringe, least of all, a basal metabolism report or an urinalysis. He insists that his pain is here and the doctor is feeling him there. He can see no relation between the blood taken from his arm and the pain in his back. The internist, in the patient's mind, is merely jabbing and stabbing, thumping and punching, and the patient prays that if only something were being done for him, he would feel that his fees which all unwillingly he gives to the internist, might have some measure of justification. He cannot appreciate the casual inquiry couched in every day language, the really important question which masquerades as simply a sympathetic conversation and which, after all, the internist has carefully studied to avoid alarm and to elicit an unguarded, but for that very reason, a more truthful answer. But tell the patient that he will have an operation and suddenly his flagging interest is aroused either in assent or in opposition. If he assents, forthwith his querulous complaint is one of regret that the surgeon has not stepped into the picture long ago. He is sure that at last something is going to be done for him. His mind is satisfied that even though there is some tremulous fear of an anesthetic and the subsequent postoperative pains which friends have graphically and horribly pictured for him as part of their hospital experience, nevertheless, the cloud has a silver lining, beyond the shadows there is light, beyond the night of uncertainty, the dawn of a better postoperative day. If his reception of the news that he is to be operated upon meets with his opposition, the arguments themselves are quite interesting. Slowly, so he assures himself, his fears must give way to reason and when finally a seemingly unwilling consent is wrested from him by the force of logic and the solution of the physician's delemma, in most cases, the assent is finally willing enough. The surgeon's omnipotence and implied omniscience triumph over the internist's cautious and careful diagnostic hesitation. The patient may later on quarrel about his fee, but somehow he understands a one hundred dollar bill for an operation, while a fifty dollar bill for medical attention and laboratory work leaves him gasping.

Besides that in the popular mind, the surgeon has come to be regarded as the physician *par excellence*, the embodiment of what is best and most difficult and most worth while in the field of medicine. Talk to a popular audience about the education of the physician and the first thought that leaps into the uninitiated mind is that of learning how to do operations. The popular mind understands that a student of medicine must study anatomy because anatomy is necessary for performing operations, but that same mind scarcely appreciates the meaning of biochemistry or physiology in the preparation of the physician. Somehow, surgery is regarded as being closer to ourselves and our human bodies than are the intricacies of hematology. When a capsule or a tablet is swallowed, it disappears; when the surgeon has done his work, the wound is there as evidence of his job. The psychology of self-interest is played upon.

Yes, we may go even farther. The surgeon is even endowed by the poetic mind with an almost priestly character. Witness this quotation from the "London Tablet" of about 20 years ago, a quotation which I have preserved in my notes from the days when my own poetic appreciation

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of medical practice was most keen and before, let me say it most reverently and respectfully, the poetic and imaginative had ripened into mature convictions through the tempering influence of daily reality and almost hourly contact with surgeons and physicians. The quotation reads:

> Is there any position of man at labor or service that resembles the attitude of the priest at Holy Mass after he has consecrated the Host, and stands with his hands held out aloof from all other touches? No one who has habitually noticed the living cross at the altar of sacrifice, can fail to remember it in the operating room of any hospital when he sees the surgeon holding out and holding up his purified hands on either side, standing in the form of a cross before the operating table. The ritual of aseptic surgery as it is practiced every year with more exquisite detail of scrupulosity, shows us this minister at the table, which resembles an altar of human suffering, clothed in white clothing like a priest's alb, and in strange and significant posture, all unconscious of the symbolism of the similitude.

The picture is a beautiful one, full of elevating suggestiveness and enthusiastic idealism. What is more important, it is in a measure full of the beauty of truth, particularly when applied to some of the surgeons whom any one of us might mention by name, even though one might wish that more such might be worthy of the elevated ideal which the writer of those lines obviously had prominently in mind.

And then there is the word of the surgeon. It is eagerly waited for after the operation. Somehow, the patient and all his friends and relatives feel that since the surgeon has actually looked within the body of the patient, he must know what is there. The internist is implicitly thought of as being at a disadvantage because he has not seen and can only surmise. The internist explains, the surgeon simply states. The internist is regarded almost as offering an apology for his delay in reaching a conclusion; the surgeon as defining a fact. Tears may flow despite reassuring rhetoric of the internist, but let the surgeon pronounce one reassuring sentence and the lacrymal wellsprings of grief cease to flow. If the patient dies after operation, everything humanly possible has been done; if the patient dies without having been operated upon, there still remains in the minds of all too many, a lurking shadow of a fear that perhaps not everything humanly possible has been done and those fears sometimes in the mind of an oversolicitous relative takes shape in persistent self-incriminating psychosis.

Now, the point in all of this is to bring out the huge burden of responsibility which is carried by surgery. Not only in the good name of medicine and medical practice so largely in the hands of the surgeon, but what is also true literally, a huge proportion of medical practice is actually the direct responsibility of the surgeon.

We might well illustrate both sections of this compound statement. First of all, the surgeon carries a huge responsibility for the maintenance of the good name, of the ideals, and of the ambitions of the medical profession. The very esteem in which the surgeon is held is the best evidence we can adduce for the actual existence of this responsibility. The public trust in the profession is the treasure beyond price which is entrusted to so large an extent to the careful watchfulness of the surgeon. The measure of medicine's public service is frequently thought to be the measure of the surgeon's service. The dramatic achievements of present day surgery have, it may as well be admitted, done even more to enlarge the public's confidence in medicine and medical practice than even those triumphs in which the public has evinced such interest, as those of hormonal therapy. After all, in this latter field, the public somehow knows that the individual physician is simply applying to an individual patient the results of the combined scientific experience of the laboratories, while the intimate personal relationship between the patient and physician somehow individualizes the sufferer more than does the prescription which calls for a previously prepared dosage of drug or hormone. The recent triumphs of neurosurgery have startled the popular ignorance. The achievements of thoracic surgery with its results in reducing mortality and in reducing the duration of illness in one of our most dreaded enemies, tuberculosis, have appealed to thousands whose individual lives as patients or as relatives of tuberculous patients, have been affected by this disease. Much of the interest in the cancer problem is focused in the popular mind in the surgical aspects of cancer. The lurid descriptions retained by patients in their memories years after an operation, whose genesis is a modest and simple statement by the operating surgeon but whose evolution progresses startlingly and dramatically with each telling and each comparative repetition, is but a further illustration of the popular interest in the subject we are discussing. It must be granted that an appreciation of the science of medicine is largely engendered by the popular understanding of surgical problems. An appreciation of the art of medicine is equally engendered in the public by an appreciation of the artist, the surgeon, who is thought of as having achieved such marvels. These cicatrices of operations are said to be beautiful, the work of an artistic wielder of a scalpel. They can be readily compared in different patients by admiring eyes.

The surgeon himself, as the bearer of the responsibilities of the art of surgery, is responsible, though, of course, I do not mean culpably responsible, to no little extent, for the popular attitude. Some day when one's heart and mind are fancy free, one might profitably, and surely pleasantly, employ the time in sketching a contrast, the contrast between the composite picture of surgeons whom one has known and the composite picture of internists whom one has known. Here I would only briefly touch upon this contrast in its bare outlines. Of course, there are surgeons and surgeons, just as there are internists and internists. But taking them in the large and as a group, perhaps we would all agree more or less, that the surgeons are a more comfortable as well as a more comforting group to meet. I submit without being dogmatic that there are more voluble internists than there are surgeons; more cheerful, more humane, more jovial surgeons than internists, more dignified and majestic surgeons than internists. If I had to describe all the internists whom I have known by just one word, I would probably select as my descriptive epithet "cautious reticence" as best expressing a composite characteristic. The science of medicine stands out in them more than the art. If I had to choose one epithet for all the surgeons I have known, I would probably express my thought best by choosing the term, "trust-producing." The art of medicine stands out in them more than does the science.

Let us now cast a brief glance at the responsibility carried by medicine in terms of volume. I have casually studied a group of 25 hospitals extending from Portland, Oregon, to Lewiston, Maine, selected at random from records of all the hospitals of the country, the figures being supplied through the courtesy of Mr. Sanger, of the American Medical Association. The basis of the selection was simply the fact that the number of admitted patients should be approximately twice as great as the number of operations. Into these hospitals there were admitted last year a total of 95,850 patients. The number of operations in these same hospitals reached a total of 58,671. The number of operations, therefore, were 62 per cent of the number of admissions. I have studied the annual reports from 1927 to 1935 of another group of hospitals, 46 in number, selected entirely at random without any reference to the relation between the number of admissions and the number of operations. The number of operations ranged from 40 per cent in one of the years to 52.9 per cent in another year; the high percentages ranged from 47 per cent to 66 per cent; and the low percentages, from 22 per cent to 46 per cent. In 15 hospitals of one of our large cities there were in 1935, 65,606 patients and the total number of operations reached 40,115. The number of operations was thus 61 per cent of the total number of admissions.

Again, I took the statistics of a group of 50 Catholic hospitals selected entirely at random from a collection of more than 600 annual statistical reports. Into these hospitals, there was admitted a total of 158,363 patients during the last year; 25 per cent of these were classified as medical cases and 27 per cent as surgical, the 28 per cent remaining being made up of pediatric and obstetrical patients and of patients in the specialties. Of a total 1,980,687 hospital days, 26 per cent were accredited to the medical and 44 per cent to the surgical divisions of the institutions. There was one general hospital in which the number of surgical patients was listed as being 79.4 per cent of the total and in that same hospital, 78 per cent of the hospital days was credited to the surgical division. Among these 50 hospitals, there were 21 whose surgical cases ranged between 31 and 45 per cent of the total annual patient census and 28 in which this percentage exceeded 46 per cent, 4 of them having a surgical percentage of 61 or over. The average stay of the surgical patient is generally assumed to be considerably shorter than that of the medical case. In these 50 hospitals, the difference between the average stay of the medical cases and that of the surgical cases was only 20 per cent, the average stay of the medical case being 13.9 days, and the average stay of the surgical case being 11.9 days.

In a group of 4 university hospitals into which there were admitted 36,029 patients, 55 per cent were surgical cases and the number of operations was exactly 50 per cent of the number of admissions.

It is true that these statistics can hardly be considered adequate to form a satisfactory basis for a conclusion, since despite the exercising of a certain amount of care to include only comparable data, I have no doubt but that some inaccuracies have found their way into my hurried compilations. With this limitation in mind, however, one might still feel reasonably certain on the basis of these figures that last year somewhere near 50 per cent of the patients admitted to our hospitals were either actually operated upon or were classified as surgical cases. One may also conclude that approximately a percentage of between 45 and 57 of the hospital days were chargeable to surgery. The number of admissions to 6,246 hospitals in the country in 1935, was

7,709,942. One-half of these, on the basis of this summary, were either operated upon or were treated as surgical cases. This means that there are approximately 10,000 operations a day in all the hospitals in the country or an average of almost 2 operations per day per hospital. If all of these operations were performed in one institution and a half hour were allotted to each operation throughout the 24 hours of the day, approximately 220 operations would have to be going on at the same time throughout the entire year.

The responsibility for human life and human welfare which is being carried on the shoulders of the surgeon as evidenced by these statistical studies is perfectly enormous and all but forces us to comment upon the practice of surgery today and the trends in this important branch of medicine.

The first question which naturally rises to one's mind in connection with this problem is this: Is there really need for so much surgery? One can, of course, turn the question around and can formulate it: Why should there not be this much surgery? And finally, one may ask: Is surgery really prepared within the framework of the present practice of medicine to carry its responsibility? Let me comment briefly upon each of these questions.

Is there really need for so much surgery? It would, of course, be foolhardy for any one of us, most of all for a person who is himself not a surgeon and whose playground is rather medical education, to offer a dogmatic answer to this question. Yet, just as it is not necessary to get inside of the teakettle to find out whether the water is boiling, just so it is not always necessary to live habitually within the ethylene or ether laden atmosphere of the operating room to have some few views on this subject.

Is there need for so much surgery? Yes and no. There is need for it, since surgery demonstrably is a therapeutic measure which has contributed immeasurably to human well being. No, since again demonstrably, a sufficiently large percentage of operations have been proved to be unnecessary. We are all fully aware of the intricacies of what we have called surgical judgment. We know how hard it is to develop it in those whose life's ambition it is to become surgeons. We have seen the struggles of our conservative teachers of surgery to restrain their pupils from grasping for the scalpel at the first suggestion of an excuse for drawing blood. We know the problems of the mentor of young surgeons who pull at the leash more impatiently than hounds of the chase. We know how easy it is to suggest an operation as often the easiest way out of many a perplexing psychological problem. In the face of all of these difficulties and many others with which the life of every active surgeon is filled to overburdened satiety, the use of all the brakes possible upon the impetuosity to operations becomes enormously valuable. Professional sincerity is just as truly an indispensable characteristic of the surgeon as digital dexterity. The surgeon will welcome all the criteria which he can accumulate to test his own sincerity and competence. The standard requirements of the American College of Surgeons making it essential that all biopsy material be submitted to the investigative eye of the pathologist for his evaluation has done incalculable good in promoting sound surgical judgment, in safeguarding the public against unnecessary operations, and in developing the science of surgery itself. The use of the clinical pathological conference as a test of the surgeon's work has been too often insisted upon to demand logical persuasion, though it cannot be too often insisted upon as an agent for the surgeon's candid self-criticism. The autopsy table is the bar before which the surgeon stands as the self-accusing culprit, the spot at which he is culprit, the prosecuting attorney and attorney for the defense, with the pathologist as witness at the same time for the defense and the prosecution. When the surgeon in the pathological conference in the presence of critical colleagues and under the critical eye of the pathologist rises to the height of self-effacement and to the pinnacle of loyal devotion to his profession and to himself and admits not only, what is easier, an error in judgment, but also, what is much more difficult, his own error in technique, he has reached a new level from the sublime elevation of which he might well look down upon the path he has trod up to that moment and take comfort in the thought that he has arrived and that henceforth his future professional life will be different from his past.

Yet when all this is said and done, there remains the need for intensification of the preoperative program. One may travel the length and breadth of the land and one may still find not too rarely an institution in which certain safeguards against unnecessary operations have failed to be applied. Pre-operative diagnostic routine is still not universal. The use of tests, corroborative and affirmative, of a diagnosis is still put as a burden upon the patient for which the patient must pay instead of being used, as I think they should be used, for the ethical safeguard of the hospital and the surgeon. Flouroscopic examinations and roentgenograms are still requisitioned

and their use is encouraged as a source of revenue to hospital and physician instead of being universally regarded as safeguards to the patient with a corresponding insistence upon minimal charges rather than upon charges that are as large as the traffic will bear. Pre-operative diagnoses are, unfortunately, still written after the operation; sometimes not at all and sometimes only when their absence is detected by the vigilant eye of the record librarian during a history meeting. Operative notes are, unfortunately, dictated not during or at least immediately after the operation, but still not too rarely dictated after the patient's postoperative course has revealed to the surgeon what his interoperative observation should have uncovered. These things, even though they may not all be the observance of approved standards, demand a measure of sincerity which at times approximates professional heroism. And if it be argued that heroism can be demanded of no man, I can only answer that to be a surgeon in the highest and best sense, is to be a superman. And no man should aspire to the sacred heights of heroism who cannot rise to equal heights of self-effacement and self-dedication to such a profession.

Is there need for so much surgery? We shall be able to answer the question after we have universally introduced into surgical practice the scrupulous observance of all those demands upon the surgeon which have been formulated in response to factual conditions by those whose unselfish dedication to the cause of medical service to humanity have led them to formulate criteria of surgical practice for which this College has stood unswervingly and toward the realization of which it is striving as rapidly as the development of surgery and medicine will allow.

Is surgery a last resort? Is it an unusual method of therapeutics? If so, why is it so frequently employed? The answer to these questions again raises in our minds problems of the most serious import. First of all, our ethical principles demand that our treatment of the patient should be a safe treatment. Our ethics cannot demand of us that we employ only the safer methods. It is sufficient that treatment methods be safe, that is, that they be intrinsically capable of achieving the objective which the physician has in mind, the betterment of the patient or, in extreme cases, the offering to the patient of an opportunity to live. Judged by such a principle, when the choice between medical treatment and surgical treatment is offered, there is no intrinsic reason for choosing one rather than the other provided both methods be deemed apt for the attainment of the patient's improvement in health. When, however, as may happen, the surgical treatment of the patient creates palpable risks even though medical treatment may defer a more certain recovery, a sincere surgeon will consider more than the diseased condition and will view his problem from all the numerous angles from which light may be shed upon the dark areas of a surgical perplexity. The patient as a whole, with his pre-illness environment and his postoperative recovery environment, the psychological attitudes of the patient and of his surrounding relatives and friends, the availability of nursing service, the regimen of the patient's subsequent life, his avocation, his probable economic status, his habits—all these and perhaps as many other factors may thrust a determining weight upon one side of the scale or the other as the surgeon reaches a decision between the effective probabilities of medical and surgical therapeutics.

The science of diagnostics has today reached a point at which it is of enormous value to the surgeon. In competent hands, diagnostic techniques are, under favorable circumstances, the most valuable safeguards of the surgeon's judgment and general competence. Despite all this, we cannot but frown upon the piecemeal practice of medicine. The patient is not the gross material for a job. He cannot be shifted from one physician to another, from the diagnostician to the surgeon, in such a way that one or the other can facilely shift responsibility as if it were a package which gets itself shifted with the shifted patient. A self-respecting surgeon will always re-examine the basis of a diagnosis. He will, if he is still more sincere, demand a consultation between himself and the diagnostician. He will even, given the proper circumstances, insist upon a review and, under certain circumstances, upon a repetition of certain diagnostic procedures. He will develop an intensive diagnostic routine and a conscientious adherence to this practice as a check on his own judgment and subsequently on his own technique. If it be objected that such procedures are costly and economically unattainable, I can only fall back upon the first basic requirement of the code of ethics of the American Medical Association to which each member of organized medicine is asked to subscribe. That basic principle is this: "A profession has for its prime object the service it can render to humanity; reward or financial gain should be a subordinate consideration. The practice of medicine is a profession." The physician and the hospital, when actuated in practice and not merely in theory or as an expression of an ideal by such a basic ethical consideration, will

find ways of bringing about more ample consultations, a more careful and comprehensive record system, a more exhaustive diagnostic routine without unduly increasing the costs of medical care. I submit just in passing that the socializing of medicine is no answer to the problem since in the odorous and heavy atmosphere of socialized medicine, ideal medical practice has thus far not been known to thrive. The answer lies rather in the creation of a universal atmosphere of professional idealism within which the ideal practice of the individual physican can thrive and blossom. The answer lies in the creation of a social environment upon so high and ethical a level that in it the high ideals of medical practice find a congenial environment.

Is surgery the last resort of therapeutics? Emphatically, no, if we may postulate in physician and hospital alike, that idealism which with proper safeguards to surgical procedure, views the operation solely from the viewpoint of the patient's betterment. With our enormous development in anesthesia, many of the dangers in surgical treatment are rapidly disappearing. The former postoperative discomforts of patients have, to a large extent, become a thing of the past. In well regulated surgical practice, the ghost of infections has at last been exorcised. Diagnostic procedures can be used with a measure of assurance heretofore thought almost foolhardy. The inter-relationships of diagnosis, drug therapeutics, and surgical therapeutics are becoming more intimate and interdependent. If all this is granted, or even granted in part only, it may well be that far from being a last resort in the safeguarding of the health and life of the patient, the surgery of the future may become, to an even greater extent than in the past, the therapeutic method of choice. But all of this is true if surgery interpenetrates itself more and more completely into the viewpoints, the methods, and the basic philosophy of medical practice as a whole. In other words, this is true if surgery becomes more and more universally recognized as a science and an art instead of being esteemed as, unfortunately, it still is to too large an extent, a daringly challenging technique or, as it is in still other quarters, as the simplest way out of a perplexity.

Is surgery prepared to carry its responsibility? Again, the answer cannot be an apodeictic monosyllable. In the face of surgery's triumphs in the past, within sight almost of the places where a Keen broke the untrodden pathways into the fields which today the surgeon roams with almost careless abandon, it seems almost ungrateful and perhaps somewhat cynical to raise such a question. And yet the surgery of Keen's day when he performed the first gastro-enterostomy in America within the limits of this state and continued his epochmaking work within the confines of this city, is quite a different thing from the surgery of today. In his day Listerism was a new thought; today we can scarcely conceive of the crudities of those early experiments in asepsis and especially of antisepsis. We have gone far in three-quarters of a century. Have we kept pace with these developments in the education of the surgeon?

If it be answered that it was a surgeon who effected these developments and, therefore, that surgery must surely have kept pace with itself, I can only answer that not every surgeon by far has kept pace with surgery; I can only answer that some surgeons, far from promoting the progress of the science and art of surgery, have been, and probably still are, the greatest hindrances on the pathway to the conquest of human suffering by surgery.

We have seen a revival of interest in the preparation of the surgeon. It is one of the most promising signs of the day that those surgeons who in their daringly cautious inroads into the hidden recesses of the human body are the very ones who are demanding more and more preparation of the surgical novice of today. They do this conscious of the fact that the twilight zone of surgery has been pushed farther and farther toward an ever receding horizon on the entire periphery of surgery. While the circle was narrow, less could be demanded of him who stood in its center because he had that periphery almost within reach. Now that that circle has widened so immeasurably, before one sends out the inexperienced from the relative safety of its center, one must be more sure that the pioneer—and each one of us is a pioneer when we begin our life's work—will proceed with the cautious surety of the explorer who goes out to win. It is for this reason that so much insistence has been laid recently upon an adequate basic scientific preparation of the surgeon. Anatomy, physiology, especially pathology, have all been thought of as making enormous contributions, not only to surgical theory, but even to surgical practice and surgical technique. We are past the day when to prepare a surgeon means merely to demonstrate tools and to study topographic anatomy. Today, the basic preparation of the surgeon includes his understanding of the physiological processes, his understanding of physiological pathology, of bacteriology and especially of biochemistry to a degree that falls little short of the corresponding demands in the field

of internal medicine. The establishment of a National Board of Examiners in Surgery, the promotion of standards in surgical practice as advocated by this College, the increasing provisions made for the more effective work of the surgeon in our hospital operating rooms, the stress laid upon the more complete equipment of surgical emergency rooms, and the insistence upon minimal routines even in emergency work, the development of residencies of 3, 4, even 5 and years' duration, as a preparation for specialization in surgery, the increasing requirements of the American Medical Association and of the specialty boards as a preparation of the specialist, these and all similar phenomena are an indication to us of the growing consciousness within and without the profession of the responsibilities carried by the surgeon, responsibilities which, to be adequately borne, require a constantly increasing preparation. I hope that countertendencies may not be allowed too much license. I hope that the scalpel and the forceps may be kept out of the hand of the recent graduate in medicine; I hope that he may be taught the value of observation of his older colleagues, that he may be shown the gain to himself and to his patients, of surgery under expert supervision. In the face of the responsibilities of surgery, I cannot sympathize with those who would throw an unduly large proportion of these responsibilities upon those whose fingers may be nimble and steady but whose judgment of the patient as a whole is probably too immature to permit of the shouldering of a responsibility for human life. I hope, too, that in certain areas of surgical interest, involving as they do what have heretofore been called minor operations, reasonable surgical safeguards may not be neglected as they have a tendency to be neglected, either under the stresses imposed by the volume of surgery or under the worst stresses affect but careless negligence in hospitals in which control is more or less lacking. I hope, too, that the young surgeon will be taught the meaning of pathological structure and of the pathological processes as his own greatest aid in understanding the relationship between the diagnosis and the technique. The relationship between a gross pathological specimen and the microscopic slide is still too often lost sight of and even more often neglected is the relationship between the pathological specimen and the patient as a whole. In fact, one may doubt seriously whether the terminology "a pathological specimen" must not, in the light of present day knowledge, yield to a less committing term. We have learned that the change from normal to abnormal tissue is not a sudden thing but something progressive. We have based our public education programs for cancer prevention upon the thought of progressive changes in cell-structure and have thereby accomplished much toward effacing from the surgeon's mind the old interpretation of a clinical entity or types of diseases. The re-interpretation of human disease from the dynamic viewpoint still needs to be translated not only into the mind but even into the finger tips of the surgeon. So much needs to be done even in the presence of the enormous achievements of surgery in the past that no educative process which we can devise along the lines suggested by our deepest and most capable students can be neglected to make surgery safe for mankind, and conversely, to make mankind safe from surgery.

To come back to my question, is surgery really prepared to carry its responsibilities? Yes, it is prepared and it has shown itself as prepared, but as medical science grows, so surgery must grow, and in this sense I hope that it may be true that surgery will ever continue to become more and more prepared rather than to insist that its present preparedness is perfectly capable of carrying the huge responsibilities for human betterment which have been and will be imposed upon it.

Let me bring this long disquisition to a rapid close. Surgery as a science and an art is a time honored and most effective servant of man. Its achievements are beyond the ken of any one man to grasp fully and understand. It carries with it the wisdom of age and of the ages. Old though it is, its youth is perennially revived by each new discovery and technique, by each new thought in medical practice. It is through this constant rejuvenescence that surgery will continue to serve mankind more and more efficiently and with greater stress upon the significance of the real betterment of man. The surgeon is the personification of this abstract thing that we call surgery. He is the bearer of these responsibilities, historian of the past but the prophet also of the future. He basks in the sunlight of knowledge, but he peers equally into the twilight of future uncertainties. His must be an active mind but also a nimble hand. He has done much to keep himself a fit exponent of science and service. It is society's duty to keep him prepared for his battle with disease, to afford him what he needs in the aid which he gives each of us in the struggle with disease and death.

# CLINICAL CONGRESS TECHNICAL EXHIBITION

THE leading manufacturers and dealers in surgical instruments, hospital apparatus and supplies, diagnostic and therapeutic apparatus, pharmaceuticals, and publishers of medical and surgical books were represented by attractive displays in the Technical Exhibition of the Clinical Congress of the American College of Surgeons at Philadelphia, October 19–23, 1936, at the Bellevue-Stratford Hotel. The following firms were represented:

**W. D. Allison Co.,** Indianapolis, Ind. Physicians' office furniture.

**A. S. Aloe Co.,** St. Louis, Mo. Surgical instruments and apparatus.

**American Cystoscope Makers,** New Yc k. Cystoscopes, diagnostic instruments and tube-gap radio knife.

**American Hospital Supply Corp.,** Chicago. Baxter's intravenous solutions in vacoliters; oscillating bed for treatment of cardiovascular diseases.

**American Safety Razor Corp.,** Brooklyn. Detachable blades for surgeons' knives.

**American Sterilizer Co.,** Erie Pa. Sterilizers; operating light and table.

**D. Appleton-Century Co.,** New York. Medical and surgical books.

**C. R. Bard, Inc.,** New York. Catheters, rubber drains, bougies.

**Bard-Parker Co.,** Danbury, Conn. Knives and scissors with detachable blades; sterilizing solution.

**W. A. Baum Co.,** New York. Lifetime Baumanometer and Air-Flo control.

**Becton, Dickinson & Co.,** Rutherford, N. J. Exhibit of actual manufacture of B-D thermometers and Asepto syringes; Ace bandages, Erusto and Yale needles.

**Bell & Howell Co.,** Chicago. Motion picture apparatus; cameras.

**Bilhuber-Knoll Corp.,** Jersey City, N. J. Pharmaceutical products.

**Burdick Corp.,** Milton, Wis. Electrosurgical apparatus.

**S. H. Camp & Co.,** Jackson, Mich. Physiological supports.

**Wilmot Castle Co.,** Rochester, N.Y. Sterilizers, operating light.

**Cincinnati Scientific Co.,** Cincinnati, Ohio. Pavaex apparatus.

**Clay-Adams Co.,** New York. Wax models, skeleton, rubber drains.

**Warren E. Collins, Inc.,** Boston. Drinker respirator, metabolism apparatus, apparatus for treatment of vascular diseases.

**Crane Co.,** Chicago. Hospital plumbing equipment, drinking fountain, aspirator.

**Crescent Surgical Sales Co.,** New York. Detachable scalpel blades.

**Cutter Laboratories,** Berkeley, Calif. Dextrose solution in Saftiflask.

**Davis & Geck, Inc.,** Brooklyn. D & G sutures and ligatures, Kalmerid catgut, surgical motion picture exhibition.

**DePuy Manufacturing Co.,** Warsaw, Ind. Metal splints, fracture appliances.

**Duke Laboratories,** Long Island City, N. Y. Elastoplast, Mediplast, Aquaphor, Nivea Creme.

**Eastman Kodak Co.,** Rochester, N. Y. X-ray plates, films, cameras.

**J. H. Emerson,** Cambridge, Mass. Diaphragm respirator, infant respirator, suction pressure apparatus for peripheral vascular disease.

**Foregger Co.,** New York. Apparatus for administration of anesthetics.

**General Electric X-Ray Corp.,** Chicago. Mobile oil-immersed shock-proof x-ray unit; electrosurgical unit; diathermy apparatus.

**Hamilton Manufacturing Co.,** Two Rivers, Wis. Furniture for the physician's office.

**Fred Haslam & Co.,** Brooklyn. Stainless steel surgical instruments.

**Heidbrink Co.,** Minneapolis. Anesthesia apparatus.

**High Tension Corp.,** New York. Electrosurgical equipment.

**Hospital Appliances, Inc.,** Pittsfield, Mass. MacEachern obstetrical bed, Mercy autopan bed with overhead fracture frame.

**Hospital Liquids, Inc.,** Chicago. Dextrose solution in Filtrair.

**Ille Electric Corp.,** New York. Portable hydromassage whirlpool bath, hydrotherapeutic equipment, underwater therapy tank.

**Invalid Walker Corp.,** Los Angeles. Invalid chair for children and adults.

**Johnson & Johnson,** New Brunswick, N. J. Ethicon sutures, hospital supplies, bandages, surgical dressings.

**Kny-Scheerer Corp.,** Long Island City, N. Y. Stuart surgical knife with removable blades; instruments.

**Lea & Febiger,** Philadelphia. Medical and surgical books.

**Charles Lentz & Sons,** Philadelphia. Surgical instruments and supplies.

**Lepel High Frequency Laboratories,** New York. Electrosurgical ultra short-wave apparatus.

**Lewis Manufacturing Co.,** Walpole, Mass. Curity sutures, surgical dressings.

**Libby, McNeill & Libby,** Chicago. Homogenized food in cans for infant and invalid feeding.

**Liebel-Flarsheim Co.,** Cincinnati, Ohio. Electrosurgical apparatus.

**Linde Air Products Co.,** New York. Oxygen in tanks for hospital use.

**J. B. Lippincott Co.,** Philadelphia. Medical and surgical books.

**MacGregor Instrument Co.,** Needham, Mass. Scannell apparatus for blood transfusion; Vim-Firth stainless steel hypodermic needles.

**Macmillan Co.,** New York. Medical and surgical books.

**Majestic Surgical Instrument Co.,** Chicago. Portable electro-surgical unit.

**Massillon Rubber Co.,** Massillon, Ohio. Matex Anode dermatized surgeons' gloves.

**McKesson Appliance Co.,** Toledo, Ohio. Anesthesia and oxygen apparatus.

**Medical Bureau,** Chicago. Employment service for the profession.

**Merck & Co.,** Rahway, N. J. Pharmaceutical products.

**E. B. Meyrowitz Surgical Instruments Co.,** New York. Stainless steel surgical instruments.

**Middlewest Instrument Co.,** Chicago. Jones basal metabolism unit.

**C. V. Mosby Co.,** St. Louis. Medical and surgical books.

**V. Mueller & Co.,** Chicago. Instruments and apparatus for the surgeon, including the Surg-O-Ray.

**Thos. Nelson & Sons,** New York. Medical and surgical books.

**Penn Surgical Mfg. Co.,** Philadelphia. Stainless steel instruments and apparatus.

**Petrolagar Laboratories,** Chicago. An exhibit of the five types of Petrolagar—plain, with phenolphthalein, with milk of magnesia, unsweetened, and with cascara.

**Physicians Supply Co.,** Philadelphia. Illuminated signs for physician's home or office.

**George P. Pilling & Son Co.,** Philadelphia. Surgical instruments and appliances.

**Puritan Compressed Gas Corp.,** Kansas City, Mo. Oxygen, ethylene, nitrous oxid in cylinders.

**Radium Chemical Co.,** New York. "All Gold" radon implant for interstitial radiation.

**Radium Emanation Corp.,** New York. Removable platinum radon seeds for radium therapy.

**Sanborn Co.,** Cambridge, Mass. Metabolism apparatus, electrocardiograph.

**W. B. Saunders Co.,** Philadelphia. Medica and surgical books.

**Scanlan Laboratories,** Madison, Wis. Fracture table, emergency lighting unit, operating room light, sutures with needles.

**Scialytic Corp. of America,** Philadelphia. Operating room light.

**J. Sklar Mfg. Co.,** Brooklyn. Surgical instruments and apparatus, including Ralk's Ideal suction and pressure treatment unit.

**C. M. Sorensen Co.,** Long Island City, N. Y. Cabinets and equipment for the physician's office.

**Spencer Corset Co.,** New Haven, Conn. Individually designed supports and binders for postoperative, pre- and postnatal use.

**E. R. Squibb & Sons,** New York. Pharmaceutical products.

**Sterisol Ampoule Corp.,** Long Island City, N. Y. Dextrose solution in ampules.

**Surgical Publishing Co.,** Chicago. SURGERY, GYNECOLOGY AND OBSTETRICS, the official journal of the American College of Surgeons; "The Joy of Living", an autobiography by Dr. Franklin H. Martin.

**Taylor Instrument Cos.,** Rochester, N. Y. "Tycos" blood pressure apparatus, Dermatherm.

**Charles C. Thomas,** Springfield, Ill. Medical and surgical books.

**Tower Co.,** Seattle, Wash. Metal splints and fracture apparatus.

**Treatment Regulator Corp.,** Detroit. Elliott heat therapy apparatus.

**Wallace & Tiernan Products, Inc.,** Belleville, N. J. Azochloramid, a new stable chlorine solution.

**Wilson Rubber Co.,** Canton, Ohio. Wiltex surgeons' gloves.

**Winthrop Chemical Co.,** New York. Pharmaceutical products.

**Max Wocher & Son Co.,** Cincinnati, Ohio. Surgical instruments and apparatus, operating room light, operating table.

**William Wood & Co.,** Baltimore, Md. Medical and surgical books.

**Zimmer Manufacturing Co.,** Warsaw, Ind. Fracture apparatus and appliances.